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Consumer mental health and wellbeing: Socially responsible consumption patterns

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Published in
Frontiers in Public Health
Frontiers in Psychology

ISSN 1664-8714
ISBN 978-2-8325-3599-8
DOI 10.3389/978-2-8325-3599-8

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Consumer mental health and wellbeing: Socially responsible consumption patterns

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Citation

Akram, U., Han, H., Jiang, Q., Fu, G., eds. (2023). *Consumer mental health and wellbeing: Socially responsible consumption patterns*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-3599-8

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 27 July 2022
DOI 10.3389/fpubh.2022.981593

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

RECEIVED 29 June 2022
ACCEPTED 07 July 2022
PUBLISHED 27 July 2022

CITATION
Fülöp MT, Breaz TO, He X, Ionescu CA, Cordoş GS and Stanescu SG (2022) The role of universities' sustainability, teachers' wellbeing, and attitudes toward e-learning during COVID-19. *Front. Public Health* 10:981593. doi: 10.3389/fpubh.2022.981593

The role of universities' sustainability, teachers' wellbeing, and attitudes toward e-learning during COVID-19

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In recent years, universities worldwide have experienced rapid changes with an immense impact, which have been influenced by technological progress and the social trends of digitalization. Like all other revolutionary changes, digital transformation involves intense adjustment/readjustment. University sustainability must be the active concern of all higher education institutions. Thus, the present research aims to analyse teachers' acceptance of new technologies and the impact on their wellbeing and university sustainability. The main objective was to analyse the acceptance of technology in special the e-learning opportunities and the wellbeing of teacher in an emergent country like Romania. To achieve our goal, we created a questionnaire based on the literature, and with the help of the technology acceptance model, we tested our hypotheses. The results indicate several discontents on the part of teachers concerning adapting to new technologies and even a personal discomfort in adapting to these new technologies. Thus, we can note that wellbeing significantly influences job satisfaction and teachers' involvement in sustainable development.

KEYWORDS

sustainability, e-learning, wellbeing, TAM, attitudes

Introduction

Today's working world has become very complex in many areas: processes are becoming more concentrated and often make it difficult for us to "switch off" in the truest sense of the word, with consequences for our wellbeing. Changing the world may be difficult, but individuals can do something for themselves and their mental health.

The concept of sustainability is more present than ever in our society and not just because of the growing presence of the *Fridays for Future* movement. Originally initiated by schoolchildren, the almost weekly demonstrations have also gained popularity among the general public. Due to the recent heated debate on climate change, many other sustainability issues have arisen in society and politics, which are also widely discussed. Society increasingly demands that companies take responsibility in this area (1).

However, not only do consumer goods manufacturers need to answer their customers' questions about sustainability, but service providers are also being monitored more and more closely. Sustainable corporate management is becoming increasingly important, and the relevance of corporate social responsibility is growing. This shift does not stop at educational institutions. Within universities, the theme of sustainability can be divided into two main aspects, namely, the educational mission of the university, and the institution itself, through its actions. As a knowledge broker, the company also expects a specific commitment to sustainability and, in general, environmentally conscious behavior from an educational institution. Universities fulfill a particular function as a model in the content it delivers. Nevertheless, in addition to social assessment, it is beneficial to consider and include sustainable issues in the management of a university. On the one hand, the economical use of resources can lead to cost advantages; on the other hand, a sustainably managed university operation can improve the university's reputation.

Sustainability can be exanimated with a macro method connected to the general economic structure, and a micro method, placing the examination on precise personnel. With regards to a commercial level, corporate sustainability can be definite as consulting the requests of a company's direct and indirect investors, not containing its aptitude to reply to the requirements of forthcoming investors (2–6). Corporate sustainability can be articulated in diverse ways, as businesses must produce and preserve the interrelated economic, social, and environmental resources, particularly if sustainability is anticipated in the long run (7, 8). In addition, Corporate Social Responsibility (CSR) has established important consideration in academic and professional discussions: scientists consider that businesses should recover the social and environmental effects of their activities, but their efforts would be directly related to the commercial approach of a business (9, 10).

We believe this paper contributes to the literature in being a good guide in accepting new technologies in academia, at least for the following reasons. First, this paper analyses the literature on sustainability and digitalisation in the university field. The novelty brought by the research aims at the impact of this process in the Romanian academic environment. So far, various studies have been carried out on the model of accepting technology in the university environment in different countries. However, we have not found such a study for Romania, so we deemed it worthwhile to analyse the situation in an emerging country like Romania. To achieve the objectives, we started with the literature analysis, followed by the presentation of the fundamental theories on education in the context of e-learning and the acceptance of technology. The theoretical component is followed by a practical part in which we present our study's results based on the technology acceptance model. We end the paper with a series of conclusions and research perspectives.

Analysis of literature on the role of sustainability in the university environment

Research on education for sustainable development in current research is grounded on the tradition of broader investigation with regards to curriculum modification. In the last decade, there have been an increasing number of papers on curriculum modification procedures in universities for sustainable change (11–13).

"Keyword analysis on e-learning" (see Figure 1) showed a more detailed and interconnected model between the impact of the pandemic, digitisation, and e-learning. Therefore, it is clear that the pandemic significantly impacted the digitisation and transition to an e-learning type of learning.

The green cluster aims at the effect of the pandemic on higher education, directly connected to the part of e-learning represented by the purple cluster. The red cluster represents digitisation and the digitisation process in the university environment.

E-learning and blended learning are essential elements of contemporary university teaching. The study models offered are as diverse as the students. With the help of innovative teaching concepts, students' learning styles can be more easily approached on the one hand, and on the other hand, we can discuss the different learning materials. Universities worldwide support students and faculty in creating and using digital courses, especially during this pandemic (14, 15).

The digitisation of higher education has recently gained widespread momentum. Although e-learning elements have been introduced since early 1990 s, there is a discussion regarding virtual universities and online studies. In addition, workshops were organized to address new media challenges (16).

In this situation, existing university e-learning strategies are checked for compatibility with current strategic guidelines. At the same time, the development of a comprehensive digitisation strategy that complements or replaces an e-learning strategy is often discussed. After a series of failures at the beginning of the millennium, awareness prevailed that e-learning in universities should not only be used as product innovation

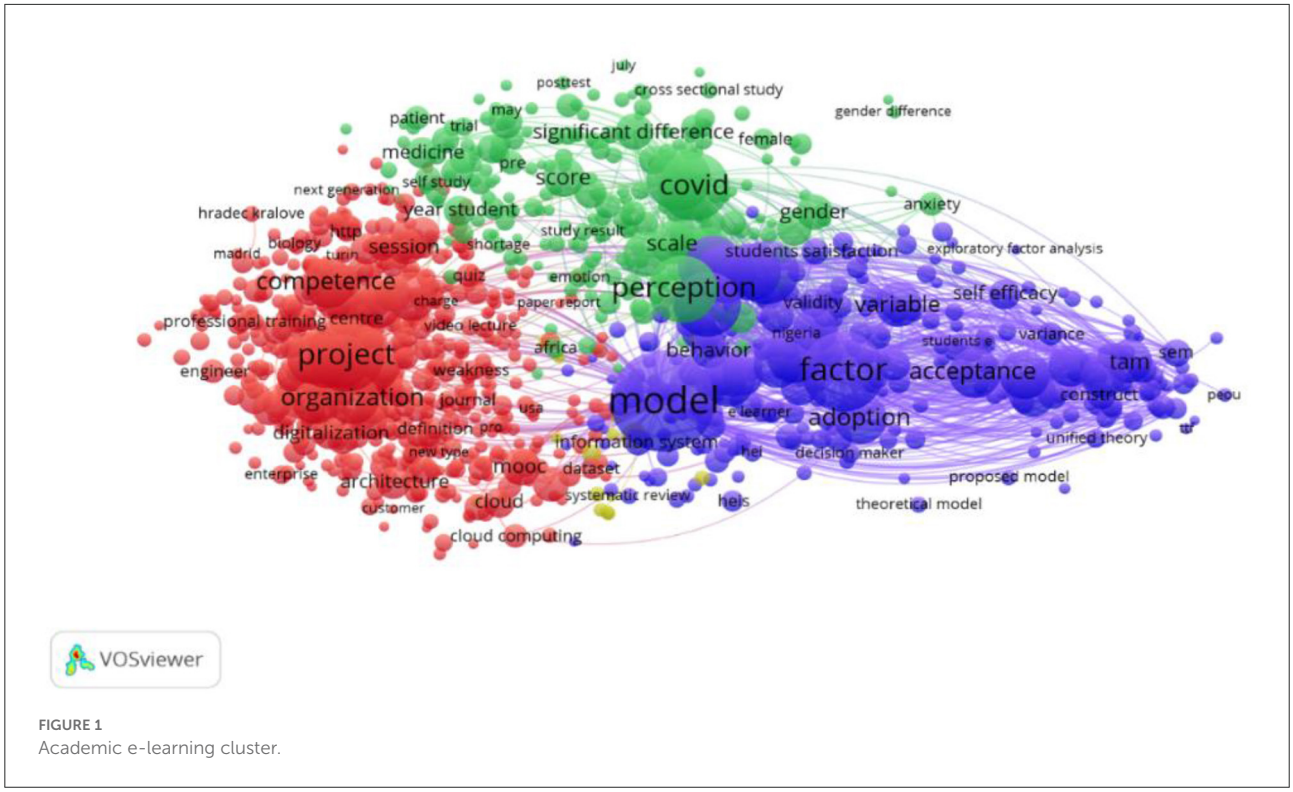

FIGURE 1
Academic e-learning cluster.

in teaching, but as a process innovation in the organization of the university. Therefore, for a long-term anchoring of e-learning, it seemed necessary not only conceiving educational media concepts, but also viable strategic guidelines for university management, developed as much as possible in a participatory process (16, 17).

Particular attention is paid in the literature to e-learning strategies and a digitisation strategy that goes beyond teaching and study. We elaborated on the advantages and disadvantages of focusing on digitalisation and sustainability of higher education with the help of the following dimensions: organization, economy, culture, and the process of change/leadership.

In a nutshell, the following conclusions can be drawn for keyword analysis. First, it was noticed that there were differences depending on terminology, referred to the aggregation level and the focal points in the content. On the other hand, the topics and considerations at the university level were found in all terms. Especially at the individual level, the ability to transfer, get involved and the competence in sustainability related to the topic of education. The different terms have all been viewed in the context of sustainable development and digitisation. They have shown intersections in R&D, technology, and information management, especially during the pandemic. On closer inspection of the implications of the pandemic, we can see a close link between digitisation and the sustainability of universities.

From fundamental theories of learning to didactics in the e-learning context

Behaviorism, cognitivism, and (socio-) constructivism have developed before the digital age (18, 19). Can these "pre-digital" learning theories describe or shape learning in the digital age? (20). If one asks the Canadian media education specialist Siemens, the answer is clearly "No!" George Siemens does not leave "no," but with "connectivism," he offers a model that claims to be a theory of learning for the digital age. Siemens' initial view is that the learning opportunities resulting from the Internet cannot be processed by the "classical theories of learning," such as behaviorism, cognitivism, and (socio-) constructivism. Therefore, it is essential to express a theory of learning for the digital age: Behaviorism, cognitivism and constructivism are the three general theories of learning, most often used in creating learning environments (21–23).

Reversed classroom approaches also provide virtual knowledge transfer, for example, video lectures to prepare or Blogs, wikis and social networks allow for social and collaborative learning. Blended learning, on the other hand, is based on integrating digital content into face-to-face formats, i.e., a link between the online and offline phases (24, 25). This accomplishes a variety of classroom methods—and electronic tools complement the social aspect of personal communication. Optional, selective enrichment of classroom teaching, for example, through a PowerPoint presentation, must

be distinguished from this. Electronic assessments and exams are available for preparing digital exams with fast feedback and actual exams and assessments. Pioneering projects promise the use of artificial intelligence (AI), augmented reality (AR) and the integration of playful elements (gamification) or 360-degree videos.

Vocabulary learning, conversation exercises, exam preparation, technical discussions, or direct access to materials: Digital learning opportunities, also known as "Using Information and Communication Technology (ICT) to Learn," are used as a variety of learning tools. They contrast with the "learning to use ICT" approach, in which digital media manipulation is learned as an end in itself, for example, using an Office program. Stationary computers or mobile devices, which can be used in many different ways, are indispensable for digital learning (26, 27).

A look at teaching practice shows that many formats and forms of application of digital higher education that can be found in universities. Online courses largely complement the classic face-to-face teaching. For example, students prepare for video seminars, complete self-learning programs during the event, or create group presentations using digital media. In addition, the university promotes a full range of blended learning formats, meaning that teaching and learning videos, virtual labs and interactive learning platforms are part of students' daily lives.

The didactic problem is also closely related to the reflections on the learning theory. In other words, reflections on the theory of learning make it possible to lay the foundations of didactics. In principle, teaching can be defined as a method. As a method, didactics can be understood as a regulated procedure for developing teaching/learning scenarios and as a moderation strategy in teaching/learning contexts (28). Didactics as a method is preceded by "methodology" or reflection: what is teaching and learning and how and why teaching and learning should take place.

Learning theories can be understood as teaching methodology. By linking didactics to learning theory, it is possible to provide a scientific basis for teaching models.

Integrating new media into teaching takes advantage of the almost explosive increase in internet users among students. The flexibility of studies with the help of new media has a possible added value for these groups more than their conventional counterparts. However, this can only work if target groups also have adequate access to e-learning opportunities.

As a rule, first-year students already have several previous experiences with new media. The individual acquisition of new media in adolescence is more leisure-oriented and hedonistic. Computers and the Internet are used primarily to provide entertainment (music, movies, games), get information about leisure activities, and communicate with other young people. They are primarily more straightforward instrumental skills in dealing with standard applications that are acquired in the context of media socialization.

However, the ability to reflect on the media and it usage, and creative-active usage is less pronounced. Thanks to previous experience, most students quickly find their way into campus information systems and learning platforms. When it comes to downloading course materials or e-mail communication, most students have no problems—especially if the browser or the e-mail is familiar.

In addition to this knowledge and skills, motivational requirements are also necessary. As has been repeatedly shown in various studies, the increased use of new media is accompanied by expectations. Students expect their teachers to be available by e-mail or instant messaging chat and support courses with electronic materials.

Integrating new media into teaching is already based on the individual requirements of students. However, it also creates new situations where one can practice dealing with new environments and learn new applications. Therefore, the use of new media in the context of teaching is in no way reduced to the role of mediator. On the contrary, the fact that the use of new media in teaching and learning contexts interacts with the aims, content and methods is always emphasized by media didactics (29–31).

The main frame of reference for integrative media teaching is all the communication contexts. Communication using new media—inside and outside the courses—is part of this practice (32). Using the media is not an end, but its use is very context-dependent. Before students can access e-learning offerings, they must first learn how to operate the learning management system. What is this benefit, mainly if two or three learning platforms are used in a course? However, if students of educational sciences already use a learning management system during their studies, e.g., Moodle, which they will use later on, it can be an advantage for them. For the innovation process to be put into practice in the long term, obstacles to applying new teaching and learning scenarios must be removed.

Therefore, at this time, in the field of teachers' training, there is a plea for media priority and media scenarios that can be used in pedagogical areas of action. The consequences of integrative media teaching on a university's media development plan are obvious. Different areas of competence are already relevant throughout the study. Based on students' future action areas, other computer-supported communication and interaction processes are given prominence in educational studies (33, 34).

The role and impact of accepting technology on wellbeing

"Acceptance" explains a behavior or attitude depending on an acceptance object. As an object of acceptance, it means technical, organizational, institutional, and social changes or innovation. In this sense, acceptance is the appropriation of

something offered, available, or suggested. The different types of use require the definition of the concept of acceptance for the specific used field, so we intend to define and present an empirical study on the acceptance of technology, more precisely, the acceptance of the e-learning system (35).

The first debates on the concept of acceptance took place in the mid-1970 s. They followed the social discussion about the innovative communication technologies used to permanently change the organizational processes in companies. At the time, acceptance research was less interested in the social consequences of these new technologies. Instead, it was primarily concerned with business issues, including sales market screening, economic risk assessment, or potential analysis to prevent poor investment (36). It was not until the late 1970 s and early 1980 s that research focused on economic and social acceptance issues due to the accelerated development of technical devices and their rapid penetration into almost every area of life. This period can be described as an era characterized by an increase in technology that also affected private households (37, 38).

A significant incentive for the genesis of acceptance research based on social sciences came from the assumption of a model of the hostile attitude of the population toward new technologies. This debate has been stimulated by public opinion polls with partially unconfirmed findings, either because of a supposedly declining number of students interested in technical fields of study or because of the critical opinion of the population on the expansion of nuclear technology. However, the differentiated climate of opinion in the context of public controversies about old and new technologies has been misinterpreted as a measure of a negative attitude of the population toward new technical innovations. As a result, the description of the situation by the various stakeholders turned into a new statement in which different approaches found traction simultaneously, which is understood by difficulties of acceptance and what possibilities exist to solve them (39, 40).

However, the concept of acceptance should not be equated exclusively with the acceptance of technology. Although most publications are technology-related, the construct is discussed in almost all research areas. This broad, multidisciplinary interest in issues related to acceptance, even if not related to technology, is mainly due to the discussion on the general phenomena of social acceptance.

Acceptance is not a term derived from science but a term of everyday language. The word is used primarily in social discourse by politicians, economists, and advertisers in the form of acceptance predictions and has made an actual career use in this form. Since the 1980 s, the term has become a buzzword for advertising and the linguistic repertoire of various stakeholders.

A presentation of the definitive use of acceptance in the context of scientific questions leads to the realization that there is no uniform definition of the term here either. At the beginning of the research effort, acceptance was primarily understood as an attitude that applied to certain forms of opinion and behavior and was mixed with terms such as attitude, acceptability, or adoption. For example, Alexandre et al. understand acceptance as "an attitude of larger social groups toward individual technologies that can be determined at a certain point in time and is expressed in certain forms of opinion and behavior" (41). Similarly, but in more detail, Hilbig defines acceptance as "a more or less affirmative attitude of an individual or group toward an object, subject, or other matter" (42).

Consequently, Anstadt et al. define acceptance as an expression of a user's positive attitude toward technology, expressed in the desire to implement and use it in a specific situation (43). According to Gunasinghe et al. acceptance "contradicts the rejection term and describes the positive acceptance of an innovation by the user" (44). The use of innovation can take place on several levels of acceptance (levels of use). For example, a purely passive use would indicate a relatively low level of acceptance. In contrast, a high level of use can be depicted if a user uses innovation in various ways, i.e., beyond the expected use.

For this study, a specific definition of acceptance reflects current research findings on acceptance.

Moreover, to be happy, we must feel good about our everyday work. Above all, due to the restrictions of the pandemic and changed conditions in the home office, wellbeing is becoming increasingly important (45). When we are overly stressed, alarm bells go off in the body, and we feel unfocused and exhausted. To get out of this hamster wheel, we must care for ourselves and our bodies (46). We are aware that we perform better and feel better when we are balanced, but are companies mindful of their duty to support employees to feel good?

Today's working world is changing swiftly, and the demands on employees and managers are increasing—directly affecting wellbeing and health. Stress, the ever-increasing flood of information and work intensification quickly leads to a lack of productivity, loss of concentration and health-related days off, if there is no prevention (47, 48).

Digital technologies are increasingly penetrating our daily routines, transforming how we work, spend our free time, and interact with each other. However, while supporters of spreading these technologies expect positive effects for individuals and society, opponents fear risks such as information overload, dependencies, and loss of privacy. Given these controversies, our goal is to explore the long-term individual and societal consequences of using digital technologies (49).

In the literature, there is debate on whether digitisation's effects on individuals' lives should be assessed as predominantly positive or negative. However, with a view to future business areas, it is essential to remember that it will continue to be about fulfilling people's basic psychological needs, both online and offline. Digital tools can help meet needs in new ways, but

they must be designed to do that. A fully digital approach cannot make something successful or suitable for people (50).

While e-learning has many benefits, it also comes with some challenges. Some of these challenges can even affect our wellbeing. The e-learning environment offers many advantages, such as ease of use, flexibility, and accessibility. However, while online learning offers many benefits, it also comes with challenges. These challenges can affect our wellbeing (51). The WHO defines wellbeing as a "state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity." The top three challenges affecting learning progress and wellbeing during the e-learning process are: isolation, computer skills and setting priorities (52–56).

- *Isolation:* While self-paced learning has significant benefits, the online environment can often feel lonely. The feeling of community, in an online context, is a complicated subject, especially when completing tasks and working through modules alone. While the traditional classroom offers face-to-face encounters, conversation, and socializing opportunities, we know these types of connections are rare or impossible online (52, 55).
- *Computer skills:* With rapidly changing technologies, it can be challenging to keep up with the latest computer functions and features, especially for online platforms, as new software and other media are constantly coming onto the market. The flood of new technologies and the steep learning curves can affect our wellbeing. One may feel overwhelmed by the sheer volume of new information and skills needed to process the provided information (53, 54).
- *Setting priorities*: Online learners are usually not just learners. It can be challenging to prioritize deadlines, assignments, and examinations, especially when everything is necessary and simultaneous. Effective time management is the best way to solve this problem (56).

It is essential to realize that we must take care of our wellbeing amid chaos. Even if it takes longer to reach our goals, it is not worth sacrificing our wellbeing.

Research methodology

A questionnaire was designed based on the literature and subsequently sent to teachers to obtain an x-ray of the status and challenges they face in adopting e-learning (Table 1).

Specifically, the questions are about perceived usefulness and perceived ease of use. The first section deals with the personal information of faculty members that reflects their field and experience. The second section focuses on e-learning levels of use.

TABLE 1 Items selection based on the literature.

1	Perceived ease of use	(57–68)
2	Perceived usefulness	(57–61, 63–73)
3	Ability to use	(57, 59, 62, 65, 66, 74–76)
4	Attitude toward use	(57, 67)
5	Satisfaction and personal development	(57, 63, 64, 68, 73, 77)
6	Behavioral intent to use	(57, 59, 61, 63, 65–68, 73, 78–85)
7	Course content and design	(65, 68, 86–88)
8	Instructor contribution	(57, 65, 89, 90)
9	Actual use	(66, 91)
10	Previous experience in e-learning	(57, 65, 67, 92, 93)
11	The quality of the e-learning system	(67, 94–96)
12	Academic performance	(64, 68, 97–100)

The 36 items include respondents' perceptions and barriers to learning resource availability, material comprehension, learning attitudes, ease of access, delivery methods, and interaction patterns. In this study, respondents' perceptions were obtained from the learning they experienced in terms of models of interaction with lecturers, interactions with other students, the availability of support facilities, including Internet networks, and the availability of teaching materials in the e-learning system. In a structured way, this perception implies indicators of perceived use and ease of use. The answers to the questions on the technology acceptance model and the items of the subjective norm were recorded using a five-point Likert scale, corresponding to the original questions: 1 = "total disagreement" to 5 = "total agreement".

Based on the technology acceptance model by Davis (101), we propose the following model and hypothesis to be tested (Figure 2).

The data was collected using a survey conducted using the CAWI (Computer Assisted Web Interview) technique. A link to the electronic questionnaires was distributed to teachers and individual students at Romanian universities through the university's e-mail system. These were distributed between January and February 2022. A total of 243 completed questionnaires were received from teachers.

Results and discussion

Below we present the results obtained on the 12 elements and the 36 related items to have an x-ray on teachers' perceptions regarding the acceptance and use of the e-learning system.

Skills development is increasingly recognized as an essential condition for the sustainable anchoring of new forms of learning and media in the university. It initially refers to teachers'

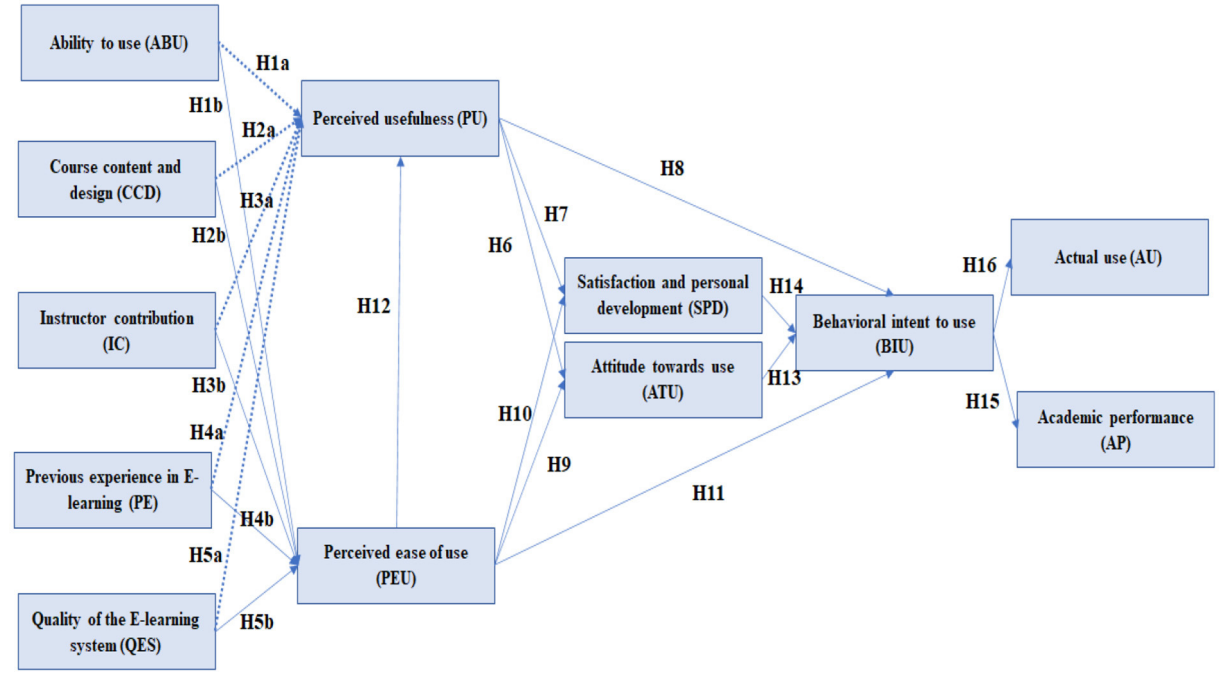

FIGURE 2
Hypothesis development.

knowledge, skills and attitudes toward the development, introduction, and use of innovative forms of e-learning in teaching. In addition, skills development also includes an institutional level; it also affects the ability of an organization to provide specific quality services. For this reason, many universities can increase efforts to motivate teachers to innovate in e-learning and reorganize or set up processes and structures of support facilities to build this competence at the individual and organizational levels. Computer skills are only a tiny part of "e-learning skills." The demographical characteristics of the sample are presented in Table 2.

As in the case of the first and second models, we started with verifying and validating the data. Therefore, the first test applied was the validity test which indicates a value of 0.915 with a sig. 0.000, indicating that the sample is adequate (Table 3).

For better assurance of the suitability of the sample, we have resorted to an additional reliability test which also indicates that the sample is adequate with a Cronbach's value larger than 0.9, which indicates that the sample is, again, adequate (Table 4).

In order to highlight detail on factors related to each element, an analysis of the factor load was performed; respectively, we analyzed the elements' reliability, as see Table 5. All the values fall within the recommended range.

The correlation matrix of the data set is shown in Table 6. Correlations larger than 0.3 were statistically significant at 0.01.

Finally, we present the reliability results based on the Cronbach's index, for which a value larger than 0.7 is recommended to be considered adequate. In our case, all values are above 0.9 (Table 7).

In order to determine the fit and suitability of the model, the analysis was performed using IBM SPSS AMOS 26 Graphics. Following the analysis of the model fit indices, it is observed that it is suitable, as shown in Table 8.

It was necessary to perform preliminary tests to ensure that the elements used in the model are validated and reliable and meet the matching criteria to validate the formulated hypotheses. Thus, in Table 9, we present the results of the estimates based on the path analysis (Path coefficient) to validate or reject the previously formulated hypotheses. Ten of 21 hypotheses were rejected due to a higher value for P of 0.001, indicating no or insignificant influence between variables (Table 9).

As it results from validating the assumptions from the external factors, the content and design of the elective course and the use skills are validated. The use of skills by teachers is a vital percentage when it comes to e-learning. It is also imperative to think about personal wellbeing when it comes to personal skills, as it can significantly contribute to how knowledge is transferred. A vital issue during the pandemic also affected self-control; if we thought we were isolated, we would face developed IT knowledge. Acquiring technical skills and teaching skills at the same time has been a challenge for many teachers. However, it is a necessary process, due to the complexity and multifaceted nature of e-learning. The study

10.3389/fpubh.2022.981593

TABLE 2 Demographic results regarding the teachers involved in the study.

	No. answer	Percentage
Category of teachers		
Assistant	34	13.99%
Lecturer	100	41.15%
Assistant professor	75	30.86%
Professor	34	13.99%
Total	243	100%
Age group		
21–30 years	25	10.29%
31–40 years	48	19.75%
41–50 years	85	34.98%
51–60 years	66	27.16%
Over 60 years	19	7.82%
Total	243	100%
Work years (experience)		
1–5 years	36	14.81%
5–10 years	17	7.00%
10–15 years	28	11.52%
15–25 years	88	36.21%
Over 25 years	74	30.45%
Total	243	100%
University type		
Public	224	92.18%
Private	19	7.82%
Total	243	100%

TABLE 3 KMO & bartlett test.

Kaiser-meyer-olkin measure of sampling adequacy		0.915
Bartlett's test of sphericity	Approx. Chi-square	1,977.877
	df	66
	Sig.	0.000

TABLE 4 Reliability test.

Cronbach's alpha	Cronbach's alpha based on standardized items	N of Items
0.919	0.919	12

results show that teachers do not consider having acquired practical teaching skills and methodology during the pandemic. On the other hand, this knowledge gained in the approach to e-learning has been exchanged and deepened, especially between specialist colleagues and teachers. Our results align with other field results (65–67, 79).

TABLE 5 Factor load and item reliability.

Elements	Factor loading internal	Composite factor reliability ≥0.70	Convergent validity average variance extracted ≥0.50
Ability to use	0.900	0.896	0.767
	0.898		
	0.770		
Course content and design	0.877	0.856	0.697
	0.889		
	0.866		
Instructor contribution	0.866	0.798	0.736
	0.898		
	0.768		
Previous experience in e-learning	0.867	0.891	0.723
	0.856		
	0.808		
The quality of the e-learning system	0.778	0.834	0.726
	0.815		
	0.903		
Perceived usefulness	0.908	0.798	0.687
	0.898		
	0.914		
Perceived ease of use	0.879	0.804	0.713
	0.799		
	0.817		
Satisfaction and personal development	0.774	0.815	0.768
	0.813		
	0.865		
Attitude toward use	0.829	0.874	0.812
	0.912		
	0.897		
Behavioral intent to use	0.829	0.813	0.674
	0.867		
	0.638		
Actual use	0.884	0.822	0.874
	0.816		
	0.874		
Academic performance	0.914	0.897	0.830
	0.902		
	0.916		

TABLE 6 The correlation matrix.

Elements	1	2	3	4	5	6	7	8	9	10	11	12
Ability to use	1											
Course content and design	0.571	1										
Instructor contribution	0.611	0.639	1									
Previous experience in e-learning	0.193	0.375	0.354	1								
The quality of the e-learning system	0.459	0.477	0.603	0.307	1							
Perceived usefulness	0.572	0.721	0.501	0.381	0.384	1						
Perceived ease of use	0.639	0.582	0.498	0.371	0.355	0.691	1					
Satisfaction and personal development	0.512	0.779	0.487	0.314	0.404	0.764	0.594	1				
Attitude toward use	0.535	0.629	0.496	0.253	0.402	0.755	0.579	0.656	1			
Behavioral intent to use	0.533	0.745	0.484	0.347	0.369	0.792	0.591	0.855	0.730	1		
Actual use	0.307	0.396	0.381	0.351	0.334	0.326	0.381	0.337	0.352	0.365	1	
Academic performance	0.481	0.683	0.519	0.343	0.580	0.649	0.507	0.665	0.523	0.637	0.311	1

TABLE 7 Reliability of elements based on Cronbach's alpha.

Elements	Media	Cronbach's alpha
Ability to use	3.96	0.913
Course content and design	3.63	0.905
Instructor contribution	3.79	0.912
Previous experience in e-learning	3.30	0.927
The quality of the e-learning system	4.07	0.917
Perceived usefulness	3.61	0.906
Perceived ease of use	3.95	0.912
Satisfaction and personal development	3.41	0.905
Attitude toward use	4.19	0.910
Behavioral intent to use	3.43	0.906
Actual use	4.33	0.924
Academic performance	3.81	0.910

TABLE 8 Fit indices.

Indicator	Recommended values	Values obtained
Chi square	<3.00	1.943
GFI	>0.90	0.915
AGFI	>0.80	0.840
NFI	>0.80	0.913
CFI	>0.90	0.967
RMSEA	<0.10	0.071

It becomes clear that the lecturer who teaches is the most crucial factor in learning success. We note that the teachers consider that they are ready for the e-learning system, respectively, and the organization they belong to provides them with the necessary resources to access the e-learning system. Teachers who have had little previous experience with new electronic technologies have reported more often than they have had initial difficulties, and that they are overwhelmed and stressed. As a consequence, they are particularly reluctant to get involved in new media. Teachers face the challenge of rethinking these processes and critically evaluating their practical implementation.

The perceived usefulness of the information system depends on the results produced by the information system. The introduction of digitized teaching is greatly facilitated by students convinced of the benefits. Ease of use also plays a vital role in accepting the e-learning offer. It becomes clear that competencies can only be defined if there is a target framework in the university that names the scenarios intended to be implemented.

The specific benefits of using e-learning could not consistently be implemented to the satisfaction of teachers. As a result, it is often pointed out that using the platform is not always appropriate and, in some cases, it is rejected.

This study investigated the e-learning acceptance and wellbeing of teachers, especially during COVID-19, as a substitute for the traditional form of teaching in classrooms in Romania. Although there are any studies investigating students' perceptions regarding technology acceptance in the literature (57–61, 63–73), rarely any research scrutinized the teachers' perception regarding eLearning, particularly for Romania we don't find any research that study the acceptance theology model, so we consider it interesting to investigate the reactions and wellbeing of teachers in this difficulty period in that teacher don't have the possibility to teach in classroom, the only solution was to adopt e-learning. However, the weak e-learning system in Romania is a significant obstacle to keep pace with the growing educational challenges. So it was a challenge to manage a good strategy and infrastructure to continue education activities even during the crisis and in the future to establish a good and sustainable teaching and to archive the wellbeing of the teachers and students.

10.3389/fpubh.2022.981593

TABLE 9 Results of the study.

	Path coefficient	*P*	Validation
Ability to use → Perceived ease of use	0.415	***	Accepted
Course content and design → Perceived ease of use	0.276	***	Accepted
Instructor contribution → Perceived ease of use	0.042	0.312	Rejected
Previous experience in e-learning → Perceived ease of use	−0.037	0.295	Rejected
The quality of the e-learning system → The perceived ease of use	−0.015	0.737	Rejected
Ability to use → Perceived utility	0.095	0.063	Rejected
Course content and design → Perceived utility	0.472	***	Accepted
Instructor contribution → Perceived utility	−0.065	0.115	Rejected
Previous experience in e-learning → Perceived utility	0.038	0.285	Rejected
E-learning system quality → Perceived utility	0.011	0.807	Rejected
Perceived ease of use → Perceived utility	0.460	***	Accepted
Perceived utility → Satisfaction and personal development	0.751	***	Accepted
Perceived utility → Attitude toward the use	0.570	***	Accepted
Perceived ease of use → Satisfaction and personal development	0.167	0.025	Rejected
Perceived ease of use → Attitude toward the use	0.109	0.057	Rejected
Perceived utility → Behavioral intent to use	0.262	***	Accepted
Perceived ease of use → Behavioral intent to use	-.016	0.791	Rejected
Satisfaction and personal development → Behavioral intention to use	0.614	***	Accepted
Attitude toward use → Behavioral intention to use	0.294	***	Accepted
Behavioral intent to use → Actual use	0.142	***	Accepted
Behavioral intent to use → Academic performance	0.454	***	Accepted

*** 0.001.

When discussing higher education, e-learning is regularly seen as an engine of potential change. Teachers are a vital factor when it comes to university performance and sustainability. They can be seen as guardians; however, it depends on whether e-learning is used successfully. It is difficult to accept that the classroom is being somewhat replaced with a virtual environment, but to remain competitive, it is necessary to adapt to a hybrid version.

Conclusions

Universities' teaching and learning processes are constantly changing due to evaluation and continuous further development. This change can be triggered by strategic decisions within a university or due to external disruption. The sudden switch to distance learning caused by COVID-19 presented teachers and learners with new challenges.

In the discussion of higher education, e-learning is regularly seen as an instrument for changes in higher education. Competence development is increasingly recognized as an essential condition for the sustainable anchoring of new learning forms and media in the university, initially referring to the teachers' knowledge, skills, and attitudes on introducing, developing, and applying innovative forms of e-learning.

In addition, competence development also includes an institutional level; it also affects the ability of an organization to provide certain services.

There is pressure on institutions to use digital media with the aim of being able to keep up nationally and internationally. As already discussed, there is a lack of strategy for sensibly designing the digitisation of teaching and integrating it into the curriculum accordingly. The university management and the departments should consider and implement these aspects. The focus is often on the necessary technology to be acquired and used.

Today, thanks to the never-ending stream of data on the Internet, more and more people can acquire knowledge, not only in western industrial nations but also in the Third World. Moreover, educational platforms such as *Wikipedia* bring concise summaries of information prepared so everyone can understand. As a result, even people who do not have the opportunity for an academic education can expand their general knowledge through established information sites on the Internet. In recent years, universities and educational institutions have also increasingly put scientific study results, academic publications, and library databases online access to the public.

Wellbeing can be defined as an individual or collective state or procedure of experiencing oneself and others and conforming to the life conditions as favorable. However, wellbeing is understood and respected differently depending on the scientific context in which it is used.

Wellbeing is sometimes also equated with positive and negative affective components, with happiness, life satisfaction, quality of life, wellness, and the negation of illness, anomie, or health.

Subjective wellbeing is the result of comparisons. These relate to judgments of the extent to which needs, standards

of value, and attitudes have been adequately met. Objective wellbeing describes the living conditions necessary for the personal form. As a rule, a society's economic, ecological, and human capital is surveyed, i.e., its structural and security-providing possibilities to individually and collectively create the prerequisites for subjective wellbeing.

Digital forms of learning can also have an economic side, especially when online courses become fee-based. Nevertheless, industrial companies and representatives from universities and politics are promoting the digitisation of teaching, which often refers to further education and less to the undergraduate bachelor's degree.

The main limitation of our paper is that used data obtained by the sampling, maybe we can extend our research to greater number of respondents to have a better understanding of what is happening in the universities and how the teacher find the challenge about the e-learning and how they fell in this period of sanitary crises. Thus, we recommend more studies concerning technology acceptance for education purposes in Romania to cope with existing challenges regarding e-learning adoption.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

GC and MF: conceptualization. TB: methodology and funding acquisition. MF: software and data curation. XH: validation and visualization. SS: investigation. GC: resources. GC and TB: writing—original draft preparation. CI and MF: writing—review and editing and supervision. CI: project administration. All authors critically revised the manuscript and gave their final approval of the manuscript submitted for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 08 September 2022
DOI 10.3389/fpubh.2022.997682

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

RECEIVED 19 July 2022
ACCEPTED 05 August 2022
PUBLISHED 08 September 2022

CITATION
Park JH and Choi JM (2022) Smartphone overdependence and quality of life in college students: Focusing on the mediating effect of social withdrawal.
Front. Public Health 10:997682.
doi: 10.3389/fpubh.2022.997682

Smartphone overdependence and quality of life in college students: Focusing on the mediating effect of social withdrawal

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This study examines the mediating role of social withdrawal in the relationship between smartphone overdependence and quality of life in college students. These three factors were assessed in 125 college students enrolled at a college in South Jeolla Province, South Korea, from September to November 2019. Data analysis was conducted using SPSS version 27.0, including regression to test the research hypothesis and a Sobel test to assess the significance of the mediation. It was found that social withdrawal completely mediates the relationship between smartphone overdependence and quality of life in college students. Several means of improving the quality of life of college students are identified based on this finding. First, colleges could provide financial support for community programs such as membership training and club activities. Second, an in-college system could be built that enables early intervention in cases of social withdrawal in students. Third, closely linked programs could be designed to provide effective professional counseling to college students experiencing strong social withdrawal. Fourth, college faculty could receive psychoeducation on social withdrawal. Fifth, as various mediating variables may exist in the relationship between smartphone overdependence and quality of life and only social withdrawal was considered in this study, subsequent studies could consider the effects of more diverse psychological and social variables.

KEYWORDS

college student, smartphone overdependence, social withdrawal, quality of life, mediating effect

Introduction

The strong enthusiasm for education in Korean society has been a major driver of the country's rapid economic growth. This enthusiasm is reflected by its college entrance rate, which is among the highest in Organization for Economic Cooperation and Development (OECD) nations. Based on OECD Education at a Glance indicators, the Ministry of Education (1) reported a higher education completion rate of 69.8% in those aged 25–34 years, placing Korea second among OECD nations.

The college entrance rate is high because a college education increases individuals' likelihood of receiving a high wage once employed. According to an analysis of the employment rate and wages of Korean adults (25–64 years) by the Ministry of Education (1), the employment rate was highest among college and junior-college graduates, at 77.0%, followed by high-school graduates, at 72.2%. Moreover, compared to high-school graduates, the average current wages of junior college and college graduates were higher by 11.3 and 38.5%, respectively (1).

Therefore, college entrance plays a decisive role in life outcomes. However, colleges do not merely have the limited role of enabling employment or increasing earnings potential. Fundamentally, colleges provide young people—that is, college students—with a range of knowledge required for the socialization process. Further, college students' socialization is crucial also because they are going through the transitional period between the developmental stages of adolescence and adulthood; different scholars consider college students to be either adolescents or adults (2). During this period, college students break away from adolescence and undergo varied socialization processes that enable them to enter full-fledged adulthood.

College students can be distinguished from adolescents or adults by the fact that they need to achieve the major economic and emotional developmental task of preparing to become independent from their parents while forming social relationships based on their own perspectives (3). For example, college students acquire the skills necessary for maintaining expanded personal relations—romantic relationships and friendships. Additionally, they explore and establish their own values and select a career path and occupation.

College students, who are future leaders, must be provided support to grow into independent members of the society. To this end, first, college students' life conditions, which can be characterized using the concept of quality of life, must be analyzed.

Academia is, therefore, making varied efforts to improve college students' quality of life. Research indicates that factors such as family relationships, friendships, learning, employment, cultural activities, depression, and impulsiveness influence college students' quality of life (4, 5).

Thus, multiple factors affect college students' quality of life. A concept that research has recently focused on is smartphone overdependence. Because a smartphone offers diverse means of leisure, including chatting, messaging, games, YouTube, and the internet, it serves to improve college students' quality of life in many ways. However, although smartphones do provide convenience and pleasure in college students' everyday lives, their excessive use also has negative impacts, such as smartphone overdependence (6). Smartphone overdependence involves obsessive-compulsive symptoms, where the individual uses their smartphone continuously, unable to control their behavior, and feels anxiety, agitation, and other negative emotions when not using it (7). It seems that Korean society, in general, recognizes the seriousness of smartphone overdependence. The National Information Society Agency under the Ministry of Science and ICT (8) reported that 78.7% of respondents pointed to smartphone overdependence as a serious social issue. Research indicates a significant relationship between smartphone overdependence and quality of life (9, 10).

However, despite the evidence for a link between smartphone overdependence and quality of life, the detailed explanation and understanding of the relationship between the two is limited. Therefore, this study identifies and focuses on a third variable that may mediate the relationship between these two variables—social withdrawal.

College students experiencing smartphone overdependence prefer relationships in the virtual world over social relationships in the real world (7). This can lead to their being criticized by families and friends for their smartphone overdependence and ultimately to the severance of primary social relationships. This isolation results in students falling into a vicious cycle because it reinforces smartphone overdependence (11). This process indicates a link between smartphone overdependence and social withdrawal, which is a tendency to have difficulties in relationships with others and a desire to live alone (7). Indeed, research has shown that an increase in smartphone overdependence escalates social withdrawal (7, 12).

Furthermore, because social withdrawal involves avoiding social relationships and preferring isolation (13), it may be a chief factor in the reduction of college students' quality of life. Previous studies (14–16) support the significance of the relationship between social withdrawal and quality of life, indicating that while smartphone overdependence has a direct effect on college students' quality of life, it may have an indirect effect on their quality of life through social withdrawal, as well.

Therefore, this study analyzes social withdrawal's mediation of the relationship between college students' smartphone overdependence and quality of life. Additionally, practical and policy suggestions are presented for improving college students' quality of life based on the research findings.

Literature review

College students' quality of life

The first conception of "quality of life" was presented in Pigou's work The Economics of Welfare in 1920; it focused on economic aspects of life quality (17).

However, from 1960 to 1970, the limitations of measuring a nation's quality of life through the purely economic aspect of gross domestic product (GDP) were identified and discussed. The Korean government conceptualizes quality of life as "objective living conditions and the subjective perception and

evaluation of citizens in regard to [them]" and measures it by considering both objective and subjective quality of life (18, 19).

The concept of quality of life is thus being used socially by including both objective and subjective aspects. However, because of limitations in the data that can be collected by individual researchers, most assess quality of life using subjective measures. Subjective quality of life is the subjective evaluation of one's own life. Researchers measure subjective quality of life based on life satisfaction, happiness, or subjective well-being (9, 20–22).

Quality of life is far from assured in college students because the need to prepare for independent adulthood puts them in a psychologically unstable state. The biggest issue they face is adjusting to a new environment, as well as becoming independent from their parents, interpersonal relations, and occupational choice. In this context, college students' quality of life is an important matter that should be given focus (3, 23).

Smartphone overdependence

The smartphone is a device that performs functions of both mobile phones and computers and have become a necessity (7, 24). Jang and Ha (4) found that only 16.3% of college students perceived smartphones to be unimportant. Specifically, college students use smartphones as a way to spend time (while commuting time and during spare time between classes), maintain interpersonal relationships, and so forth. When Jang and Ha (4) asked respondents the purposes of using a smartphone, the responses were as follows: 53.6%, chatting and messaging (text messages, KakaoTalk, etc.); 14.1%, social network services (SNS); and 9.9%, games and entertainment.

As mentioned previously, while smartphones play a positive role in using time wisely and maintaining interpersonal relationships, they also carry various risks. A typical problem stemming from smartphone use is smartphone overdependence. Prior to 2016, the terms smartphone addiction and smartphone overindulgence rather than smartphone overdependence (2) were more common. However, as government policy characterized excessive smartphone use as a personal choice rather than a pathological phenomenon, the term was changed in national statistical reports from smartphone addiction to smartphone overdependence (2).

Smartphone overdependence signifies the "state of experiencing problematic results as the salience of smartphones increases and usage regulation reduce[s] due to excessive smartphone use" (Ministry of Science and ICT, National Information Society Agency (8). Lee and Kim (2) further defined smartphone overdependence as a "state of continually depending on a smartphone despite negative results due to excessive smartphone use, finding it difficult to regulate with one's own will, and experiencing maladjustment in daily life."

Simply put, smartphone overdependence refers to excessive smartphone use time or a significant decrease in the individual's ability to manage that use. Jang and Ha (4), who studied smartphone overdependence in college students, found that the average daily smartphone use time of respondents was 5.35 hours, with 20.9% reporting 6 or more hours of use. Jin (11) also reported that college students who are addicted to smartphones never stop using them even for short periods excluding sleeping hours and experience withdrawal symptoms. Lee and Kim (2) found that the high-risk smartphone user group accounts for 8.3% and the potential-risk user group for 20.8%.

Social withdrawal

The concept of social contraction was studied by a small number of researchers in the 1950s, 1960s, and 1970s and it began to receive increasing amount of attention in the academic circle since 2000 (25, 26). Social withdrawal means "having the tendency to have difficulties interacting with others due to a lack of interpersonal skills and wanting to spend time alone and being in a socially isolated state" (7).

As was shown by the previously proposed definition, social contraction was often mixed used with the concept of social isolation in early days (26). They are similar concepts in that both involve a lack of interaction with other people. They differ as the social contraction means voluntary evasion of interpersonal relationship, while social isolation refers to a condition where an individual is involuntarily deprived of relationship with others (26, 27).

Because people who experience social contraction have insufficient social skill of understanding other people's need, they often fail to grasp what others want them to do. These people also suffer from internalization problems, such as low self-esteem, depression, and anxiety (13, 16).

Furthermore, publically criticizing other people or conducting directly risky actions are not the characteristics of those who have social contraction. As a result, they rarely draw attention from the others and often do not recognize the danger of social contraction by themselves (26, 28). Although social withdrawal is not a clinically defined behavioral, social, or emotional disorder, it often equates to a life of being isolated from social communities as well as avoiding initiating and maintaining interpersonal relationships (13).

Clinically, social contraction is not classified as behavioral, social, or emotional impairment. However, people who suffer from social contraction not only avoid starting and maintaining interpersonal relationship but also live in an isolated condition from social communities (13). It is well known that the society is paying little attention to individuals who experience social contraction.

A review of previous studies

Overdependence on the internet and mobile phones was a research focus in the past, interest is now shifting to smartphones. Smartphone overdependence brings about a psychological dependence and results in problem behaviors (29). Smartphone overdependence in college students can have serious consequences. Jin (11) found that halting smartphone use led individuals to experience negative emotions such as anxiety, agitation, discomfort, restlessness, and frustration. This finding implies that smartphone overdependence reduces college students' quality of life. According to a study by Baek and Cho (9), college students' smartphone addiction indeed has a significant influence on their quality of life. Similarly, Park and Jang (10) found that smartphone addiction had a significant effect on the quality of life of college students in the Department of Nursing Science.

And smartphone overdependence in college students can not only trigger problems in everyday life, such as academic impairment, but also lead to a preference for virtual interpersonal relationships via smartphone over real ones (7). This effect connects college students' problems with interpersonal relationships because of smartphone overdependence to social withdrawal (30). Nevertheless, the debate on the causal relationship between smartphone overdependence and social withdrawal is ongoing. Although Kim, Park, and Shin (12) support the traditional hypothesis that social withdrawal influences smartphone overdependence, they note that multiple recent studies have indicated that smartphone overdependence impacts social withdrawal. The traditional perspective reflects that social withdrawal causes the individual to rely more heavily on the smartphone as a refuge from social isolation. However, the dominant view has shifted to the interpretation that the higher the degree of withdrawal and associated symptoms such as anxiety due to smartphone overdependence, the higher the rigidity of social withdrawal in terms of relationships with others. Previous studies (7–12) also support the presence of a significant relationship between smartphone overdependence and social withdrawal.

Because social withdrawal means failure in interpersonal relationships, it can solidify negative cognitions, such as fear of social interactions and disappointment, within the college student. Moreover, these negative cognitions can also become a major factor in reduced quality of life (14). Previous studies support the existence of a relationship between social withdrawal and quality of life. According to Lee (16), an increase in social withdrawal in college students reduced their reported life satisfaction. Jeong (14) pointed out that social withdrawal lowers the quality of life in adolescents. A study by Kim (15) further indicated that higher social withdrawal levels in adolescents lead to decreased life satisfaction.

Research method

Research model

This study examines whether social withdrawal mediates the relationship between smartphone overdependence and quality of life in college students. The research model suggested based on the results of previous studies is shown in Figure 1.

Participants and analysis method

The participants in this study were 125 college students enrolled in a college in South Jeolla Province, South Korea. The survey period was from September to November 2019. SPSS version 27.0 was used to analyze the data. Regression was employed as the main means of verifying the research hypothesis, and the significance of the mediating effect was assessed through a Sobel test.

Measurement tools

Quality of life was measured with the quality-of-life scale (31), which consists of eight items that participants responded to using a four-point Likert-type scale. Scores range from 1 to 4, such that the higher the score, the higher the quality of life.

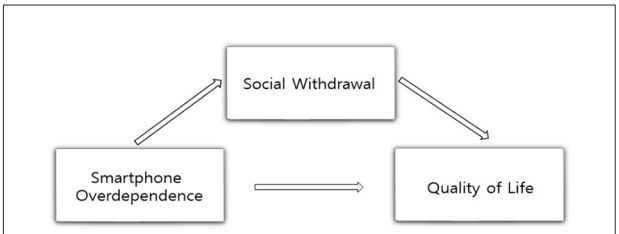

FIGURE 1
Research model.

TABLE 1 Sociodemographic characteristics ($N = 125$ people).

Category		Frequency	Percent
Gender	Female	66	52.8
	Male	59	47.2
Age	Under 25 years	108	86.4
	25 years or higher	17	13.6
School year	1st year	15	12.0
	2nd year	21	16.8
	3rd year	65	52.0
	4th year	24	19.2

TABLE 2 Descriptive statistics of the main variables.

Variable	Mean	SD	Minimum	Maximum
Smartphone overdependence	2.77	0.55	1	4
Social withdrawal	2.45	0.68	1	4
Quality of life	2.86	0.50	1	4

TABLE 3 Correlation.

Variable	A	B	C
Smartphone overdependence[A]	-		
Social withdrawal[B]	0.378***	-	
Quality of life[C]	−0.071	−0.310**	-

**p <0.01, ***p <0.001.
(A) smartphone overdependence, (B) social withdrawal, (C) quality of life.

The reliability of the scale, determined by Cronbach's alpha, was reported to be 0.807.

Social withdrawal was measured with the Korean Children and Youth Panel Survey (KCYPS) scale (32). This scale consists of five items answered using a four-point Likert-type scale. Scores range from 1 to 4, sch that higher scores indicate a higher sense of social withdrawal. The reliability of the scale was reported to be $\alpha = 0.862$.

Smartphone overdependence was measured using the Lee's (32) instrument, consisting of severn items, which were responded to using a four-point Likert scale. Scores range from 1 to 4, where higher scores indicate greater smartphone overdependence. The reliability of the scale was reported to be $\alpha = 0.832$.

The control variables of this study are gender and age. Gender was processed as a dummy variable: female = 0 and male = 1.

Analysis results

Sociodemographic characteristics

The sociodemographic characteristics of the participants are shown in Table 1. The gender split was 52.8% female and 47.2% male. In terms of age, 86.4% were under 25 years old and 13.6% were aged 25 years or older. Twelve percent were in the first year of college, 16.8% in the second year, 52.0% in the third year, and 19.2% in the fourth year.

Descriptive statistics of main variables

The descriptive statistics for the smartphone overdependence, social withdrawal, and quality of life measures are presented in Table 2. The mean score for smartphone overdependence was 2.77 points (S.D. = 0.55), that for social withdrawal was 2.45 points (S.D. = 0.68), and that for quality of life was 2.86 points (S.D. = 0.50), with all scores ranging from 1 to 4.

Correlation analysis of main variables

The correlations among the smartphone overdependence, social withdrawal, and quality of life scales are shown in Table 3. The correlation of smartphone overdependence with quality of life was not significant but that with social withdrawal was, correlating at $r = -0.310$. Additionally, smartphone overdependence correlated with social withdrawal at $r = 0.378$, indicating that multicollinearity issues did not distort the results of regression.

Verification of mediation by social withdrawal

First, the VIF (Variance Inflation Factor) values of Tables 4–6 value was smaller than 10, indicating an absence of multicollinearity problem.

The relationship between smartphone overdependence and quality of life is shown in Table 4. The model was not statistically significant.

The relationship between smartphone overdependence and social withdrawal is shown in Table 5. The model was statistically significant, $F = 6.863$, $p < 0.001$. With gender, age, and smartphone overdependence as predictors, the explanatory power of the model for social withdrawal was 14.5%. Smartphone overdependence was indicated to have a significant influence on social withdrawal, $\beta = 0.385$. Thus, the results indicate that higher smartphone overdependence predicts greater social withdrawal.

The relationships between smartphone overdependence and social withdrawal with quality of life are shown in Table 6. The overall model was statistically significant, $F = 4.921$, $p < 0.001$. Using gender, age, smartphone overdependence, and social withdrawal as predictors gave the model an explanatory power for quality of life of 14.1%. Gender and social withdrawal were

TABLE 4 Relationship between smartphone overdependence and quality of life.

Category	Quality of life				
	B	S.E.	β	t	VIF
Gender	0.194	0.092	0.195	2.100*	1.094
Age	−0.003	0.029	−0.011	−0.113	1.107
Smartphone overdependence	−0.052	0.081	−0.058	−0.640	1.027
Constant			2.985		
F			1.772		
R^2			0.042		

*p <0.05.
Dummy: gender (1 = male).

TABLE 5 Relationship between smartphone overdependence and social withdrawal.

Category	Social withdrawal				
	B	S.E.	β	t	VIF
Gender	0.064	0.119	0.047	0.534	1.094
Age	−0.011	0.038	−0.026	−0.289	1.107
Smartphone overdependence	0.474	0.105	0.385	4.517***	1.027
Constant			1.352		
F			6.863***		
R^2			0.145		

***p < 0.001.
Dummy: gender (1 = male).

significant predictors of quality of life, in that being male and having higher social withdrawal predict decreased quality of life.

Finally, the results of verifying the significance of the mediating effect of social withdrawal are shown in Table 7: the mediating effect was significant, z = – 2.869, $p = 0.000$.

Conclusions

This study examined the mediation of the relationship between smartphone overdependence and quality of life in college students by social withdrawal.

First, no significant relationship was found between smartphone overdependence and quality of life. This result contrasts with the results of previous studies (1, 22). Smartphone overdependence is the state of having a self-regulation problem with regard to excessive smartphone use (19). However, it can be assumed that voluntary excessive smartphone use (15) has no direct impact on an individual's quality of life.

A full mediated effect of social withdrawal was discovered in the relationship between smartphone overdependence and quality of life. This supports previous findings that higher smartphone overdependence corresponds to higher social withdrawal (10, 11) and that there is a significant relationship between social withdrawal and quality of life (7, 9, 16). It can be concluded that greater smartphone overdependence leads to a greater sense of social withdrawal, which eventually reduces college students' quality of life. This negative outcome indicates the need for interventions to manage college students' smartphone overdependence and social withdrawal.

College students use smartphones for purposes such as making good use of spare time during commute and between classes and maintaining interpersonal relationships (e.g., through SNS, KakaoTalk, and text messages) (6). In other words, reasonable smartphone usage can have a positive role. However, excessive smartphone use leads to smartphone overdependence. Therefore, it is necessary to make efforts to manage smartphone use appropriately. One practical strategy for preventing smartphone overdependence suggested by Forester Research in the U.S. is "tech timeout," where individuals do not use their smartphones for 1 h a day. It has been shown that not using a smartphone for just 1 h a day can help people break free from smartphone overdependence (33).

Further, research suggests that smartphone overdependence increases college students' sense of social withdrawal because excessive smartphone use leads them to prefer relationships in

TABLE 6 Relationship of smartphone overdependence and social withdrawal with quality of life.

Category	Quality of life				
	B	S.E.	β	T	VIF
Gender	0.210	0.088	0.211	2.386*	1.097
Age	−0.006	0.028	−0.019	−0.0216	1.108
Smartphone overdependence	0.066	0.084	0.073	0.788	1.200
Social withdrawal	−0.249	0.067	−0.340	− 3.715***	1.1700
Constant		3.321			
F		4.921***			
R^2		0.141			

*p < 0.05, ***p < 0.001.
Dummy: gender (1 = male).

the virtual world over interpersonal relationships in the real world (11). As a result, they lack real-world interpersonal skills and are placed in a situation where they are socially isolated (24). Hence, it is vital to develop programs that help them remain part of the social community and not become isolated. To achieve this, financial support for community programs, such as membership training, leisure program and club activities (34–39), should be made at a college level.

Also, since social withdrawal means a failure of interpersonal relationships, negative cognitions like fear of social interactions and disappointment can become solidified within the college student, which then stunts their ability to achieve a good quality of life (7). In a nutshell, social withdrawal induces varying negative cognitions and reduces the quality of life of the individual. Thus, colleges must construct a system that enables intervention where there are early signs of social withdrawal in college students. Recently, colleges have begun employing professional counselors to operate a counseling system to manage the mental health of students. They link college students who have a high sense of social withdrawal with specialized counselors to facilitate effective counseling. Along with this, general counseling through the college students' advising professor is also being introduced. However, advising professors may fail to recognize the degree of college students' sense of social withdrawal and frequently miss the period where active intervention is required. Hence, college faculty needs to be educated on social withdrawal.

Despite its significance, this study has several limitations. First, although it is probable that several variables mediate the relationship between smartphone overdependence and quality of life, only social withdrawal was considered here. Therefore, more diverse social and psychological variables need to be considered as mediators of the relationship in the future. Additionally, this study only targeted college students in part of South Jeolla Province. For this reason, research should be conducted on college students throughout the nation.

TABLE 7 Verification of the significance of the mediation.

Path of the mediating effect	z	p
Smartphone overdependence → social withdrawal → quality of life	−2.869	0.000

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author(s).

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Both authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 04 October 2022
DOI 10.3389/fpubh.2022.1038516

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

RECEIVED 07 September 2022
ACCEPTED 20 September 2022
PUBLISHED 04 October 2022

CITATION
Park JH and Choi JM (2022) The effect of residential environment satisfaction on depression in the elderly: Focusing on the mediating effect of stress. *Front. Public Health* 10:1038516. doi: 10.3389/fpubh.2022.1038516

The effect of residential environment satisfaction on depression in the elderly: Focusing on the mediating effect of stress

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This study aimed to determine the mediating effect of stress on the relationship between residential environment satisfaction and feelings of depression in the elderly. To achieve the purpose of the study, the researcher personally conducted interviews with 250 senior citizens residing in Jeollanam-do, South Korea, from October to November 2019. SPSS version 27.0 and Hayes' PROCESS ver. 4.0 were used for data analysis. As a result of testing the research hypothesis, a partial mediating effect of stress on the relationship between residential environment satisfaction and feelings of depression was confirmed. Based on these results, diverse practical and policy suggestions were recommended. First, a connection between barrier-free walking and public transportation linking elderly residences and major living facilities (transportation facilities, medical facilities, cultural facilities, social welfare facilities, parks, etc.) was suggested. Second, the application of a universal design was proposed when remodeling or building elderly residences. Third, policies promoting social participation of the elderly and providing assistance to increase the intimacy of their relationship with family members and neighbors are necessary to enable older adults to maintain their social relationships. Fourth, programs, such as educational schemes that provide older adults with a greater understating of stress, must be developed in parallel to facilitate stress self-management interventions. In future, it is necessary to include additional mediating or moderating variables to generalize these findings to the larger population.

KEYWORDS

residential environment satisfaction, stress, elderly, mediating effect, depression

Introduction

The increasing elderly population is a universal and challenging phenomenon, and among all countries, elderly population in Korea is increasing the fastest. According to the Ministry of Health and Welfare and Korea Institute for Health and Social Affairs (2017), as of 2020, 15.7% of elderly population in Korea aged 65 and over has entered an

aging society, and 20.3% is expected to enter a super-aging society in 2025. Specifically, results have suggested that 49.6% of all Korean households will be elderly households by 2047 (1).

Various social and psychological/mental issues are emerging as a result of this trend, with depression being one of the most common consequences. According to the Ministry of Health and Welfare and Korea Institute for Health and Social Affairs (2021), 13.5% of the Korean elderly population showed symptoms of depression in 2020 (2). According to the congresswoman Kang Seon-Woo, who reconstructed the data from the Health Insurance Review and Assessment Service, the number of elderly individuals experiencing depressive episodes and recurrent depressive disorder increased by 58% from 195,648 to 309,749 between 2010 and 2018 (3). This figure amounts to a nearly four-fold increase in the cases of major depressive disorder diagnosis compared with other adults. In addition, the proportion of elderly exhibiting depressive symptoms, yet without a diagnosis of depressive disorder, amounts to 15% of the total elderly population (4). Such results indicate that the prevalence of depression in the elderly population is significantly higher than the actual statistical data.

Depression in the elderly leads to personal and social loss. According to the National Health Insurance Service (2011), medical expenses of depression in the elderly increased by 123.4% between 2004 (KRW 29.5 billion) and 2009 (KRW 65.9 billion) (5). In addition, the National Institute of Mental Health (2021) highlights that depression can cause and/or exacerbate various diseases, such as cancer, heart disease, chronic pain, and diabetes (6).

Therefore, the Korean government is currently taking various measures to mitigate depression in the elderly by establishing metropolitan mental health promotion centers. Moreover, several research studies conducted by academic institutions have been analyzing that these factors increase the risk of depression in the elderly. As a result, community variables that increase depression have been gaining significant attention in recent years. In particular, the existence of a healthy and age-friendly environment, including both residential and social environmental variables, is of greater importance to the elderly than to the youngsters because of aging-related issues, such as social isolation and physical deterioration. In 2007, the World Health Organization (WHO) advocated the development of the concept of age-friendly cities, emphasizing the importance of a healthy residential environment for the elderly. A recent report by the National Institute of Mental Health (2021) also pointed out that genetic, biological, psychological, and environmental factors can play an essential role in causing depression (6).

Previous studies have also supported the significance of the relationship between residential environment satisfaction and feelings of depression (7, 8). The Environmental Press Theory explains that environmental pressure induces negative emotions in the elderly (9). Despite these findings, previous studies have not adequately explained the context of the relationship between residential environment satisfaction and depression. Koo and Chai (10) indicated that while studies investigating the direct effect of residential environment satisfaction on depression are being conducted, those analyzing the various mechanisms between the two variables are still lacking (10). In fact, Koo and Chai (10) assumed that stress should be considered the third variable in the relationship between residential environment satisfaction and depression (10).

Consequently, this study focuses on stress, which can be defined as a bodily response to the residential environment of the elderly (11, 12). When stress is increased to unbearable levels, depression increases. According to the Stress Exposure Model, continuous exposure to stress will clinically induce major depressive disorder in an individual (6, 13).

Based on previous studies, stress may be estimated to play the third important role in the relationship between residential environment satisfaction and depression in the elderly. According to the hypothesis proposed by Cutrona et al. (14), the environmental variable increases depression, with everyday stress as a mediator (14). Furthermore, previous studies support the significant relationships between residential environment satisfaction and stress (15, 16) as well as between stress and depression (17, 18).

Thus, the present study aimed to verify the mediating effect of stress on the relationship between residential environment satisfaction and depression. Through this study, we intended to present practical and policy suggestions for the management of depression in the elderly.

Literature review

Residential environment and depression

Socially, mental health is an important issue (19–21). The main issue of these mental health problems is depression. Depression is one of the emotions that people experience in daily life. Most sad emotions will disappear after a while. However, the problem is that the persistence of depressive symptoms can lead to the development of mental illness (6). Symptoms of depression appear to be different between the elderly and other adults. A distinct characteristic of depression in the elderly is the manifestation of depressive symptoms, such as concentration disorders, memory disorders, and health anxiety, without any direct complaints (4). According to a study performed by the Ministry of Health and Welfare & Korea Institute for Health and Social Affairs (2017), as of 2017, 21.1% of the elderly population in Korea exhibited symptoms of depression (1).

Among the causes for the increasing rates of depression in the elderly, residential environment satisfaction has recently attracted significant attention in academia. Residential environment is used in various concepts, including residential satisfaction and housing satisfaction, but considering that these

concepts show similar patterns, this study has conceptualized them as residential environment satisfaction (8). And Residential environment is the space within a facility building that forms the basis of human life, and when satisfaction within these spaces is high, residential environment satisfaction is also said to be high (7). The importance of residential environment is also reflected by the fact that it is stated as one of the main needs in Maslow's Hierarchy of Needs. However, as of 2019, residential environment satisfaction in Korea's elderly decreased from 2.91 points in 2017 to 2.87 points in 2019. Particularly, residential environment satisfaction has been found to be lower in the elderly than in other households (22).

Residential environments influence various aspects. The Environmental Pressure Theory provides a major perspective on the residential environment, which explains that pressure from a neighborhood environment influences the elderly and induces negative emotions (9, 23). Hence, it can be deduced from this theory that the residential environment has a significant effect on the development of depressive symptoms. In fact, previous studies also support the relationship between residential environment satisfaction and depression. According to a study by Lee and Kim (7), the physical residential environment, as perceived by the elderly themselves, has a negative effect on depression (7). Also, according to a study by Koo and Chai (10), depression in the elderly population decreases with increasing residential environment satisfaction while controlling gender, age, educational level, and marital status (10). Baik's (8) study also highlighted that residential environment satisfaction has a negative effect on depression while controlling for variables such as cohabitation with family (8).

Based on these findings, it can be suggested that residential environment satisfaction has a significant impact on depression.

The mediating effect of stress

Stress is a bodily response, implying a disturbance in homeostasis, to certain events and situations. Depending on the situation and on individual traits, some individuals may experience stress while others may not. In other words, the response to stress varies for each individual (11, 12, 24).

Although there are several well-established factors that cause stress, Eredoro and Egbochuku (12) indicated that environmental factors, such as transportation, poor housing, and pollution, may also play a major role in stress (12). Previous studies also suggested that there is a distinct connection between residential environment satisfaction and stress. According to Jin and Jang (15), among respondents residing in dormitories, students who had low levels of satisfaction with their physical living environment experienced more personal stress (14). Also, students with low levels of satisfaction with their social and psychological residential environment were more perceptive to environmental stress. Fornara et al. (16) indicated that satisfaction with the space at home has a significant effect on perceived stress (15).

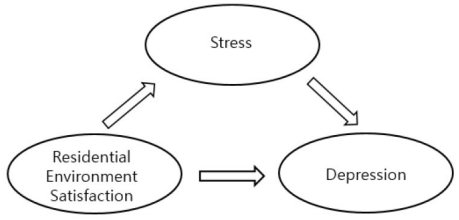

FIGURE 1
Research model.

Meanwhile, according to the Stress Exposure Model, factors such as residential environment increase stress. Also, continuous exposure to acute or chronic stress may induce or cause a relapse of clinical major depressive disorder (6, 13). Previous studies also support the significance of the relationship between stress and depression. According to a study by Shin and Kim (17), stress in elderly women had a significant effect on depression. In particular, the explanatory power of stress for depression has been reported to be 26% (17). Park's (18) study reported that stress affects depression (18).

Altogether, the results of the previous studies presented above underline that residential environment satisfaction influences the development of depressive symptoms in the elderly through stress.

Research method

Research model

This study aimed to examine the mediating effect of stress on the relationship between residential environment satisfaction and depression, and a research model was established, as shown in Figure 1.

Research subjects and methods

A total of 250 elderly individuals living in Jeollanam-do province in South Korea were included in this study. The survey period was from October to November 2019, and the researcher personally visited and conducted all interviews. Data analysis was performed using SPSS version 27.0. First, the characteristics of major variables were identified using frequency and descriptive statistical analysis. Second, a correlation analysis was performed to investigate the relationship between the variables and the problem of multicollinearity. Third, the significance of the mediating effect of stress on the relationship

between residential environment satisfaction and depression was confirmed using Hayes' PROCESS ver. 4.0.

Measurement tools

For depression, Kee's Korean version of the Geriatric Depression Scale Short Form for the elderly was used (25). The depression scale consisted of 11 items, and the responses were rated on a 4-point Likert scale ranging from "strongly disagree" (1 point) to "strongly agree" (4 points). The positive items were reverse scored with negative items; thus, higher scores indicated higher levels of depression. The reliability of the scale was confirmed with Cronbach's alpha coefficient of 0.855.

The scale used by Lee (26) was also employed in this study to quantify residential environment satisfaction (26). The residential environment satisfaction scale consisted of 16 items, and the responses were rated on a 4-point Likert scale ranging from "strongly disagree" (1 point) to "strongly agree" (4 points). Therefore, higher scores indicated higher levels of residential environment satisfaction. The reliability of the scale was confirmed with Cronbach's alpha coefficient of 0.855.

Stress was measured using the Lee's instrument (27). The stress scale consisted of a single item, and the response was rated on a 1–10-point Likert scale. Here too, higher scores indicated higher stress levels.

The control variables used in this study were sex, age, educational level, and family form, and the following were treated as dummies: sex, 0 = women and 1 = men; education, 0 = uneducated and 1 = elementary school or higher; family form, 0 = single family and 1 = cohabiting with family.

Analysis results

Demographic characteristics

The demographic characteristics of the respondents are presented in Table 1. As shown, 41.6% were men and 58.4% were women, of whom 30.8% were in their 60's, 47.6% in their 70's, and 21.6% in their 80's or older. With respect to the respondents' educational level, 26.4% were reported as uneducated and 73.6% as having education above the elementary level. As for the family form, 26.4% of the responders were single and 73.6% were cohabiting with their families.

TABLE 1 Demographic characteristics ($N = 250$).

Classification		Frequency	Percentage
Sex	Male	104	41.6
	Female	146	58.4
Age	60's	77	30.8
	70's	119	47.6
	80's or older	54	21.6
Education level	Uneducated	66	26.4
	Elementary school or above	184	73.6
Family form	Single	66	26.4
	Cohabiting with family	184	73.6

TABLE 2 Descriptive statistics of the main variables.

Variable	Score range	mean	SD
Residential environment satisfaction	1–4	2.56	0.46
Stress	1–10	4.51	2.30
Depression	1–4	2.30	0.40

TABLE 3 Correlation.

Variable	Residential environment satisfaction	Stress	Depression
Residential environment satisfaction			
Stress	−0.213***	-	
Depression	−0.400***	0.509**	-

**p < 0.01, ***p < 0.001.

Descriptive statistics of main variables

The results of the descriptive statistical analysis of the key variable are shown in Table 2. First, residential environment satisfaction was found to be 2.56 points (SD = 0.46) on a scale of 1–4. Stress was reported to be 4.51 points (SD = 2.30) on a scale of 1–10. Finally, depression was confirmed by a score of 2.30 (SD = 0.40) on a scale of 1–4.

Correlation analysis of key variables

The results of the correlation analysis of key variables are presented in Table 3. A significant relationship was found between depression and residential environment satisfaction, at r = −0.400 and r = 0.509 with stress. The correlation between residential environment satisfaction and stress was −0.213, and no issues were found due to multicollinearity.

TABLE 4 Relationship between residential environment satisfaction and stress.

Classification	Stress		
	coeff	se	t
Sex	0.334	0.310	1.08
Age	−0.027	0.024	−1.11
Educational level	−0.081	0.362	−0.22
Family cohabitation	0.059	347	0.17
Residential environment satisfaction	−1.151	0.328	−3.51***
constant		9.310	
F		2.853*	
R^2		0.055	

*p < 0.05, ***p < 0.001.
Dummy: sex (1= male), education level (1 = elementary school or above), family form (1 = cohabiting with family).

Verification of the mediating effect of stress

Table 4 demonstrates the relationship between residential environment satisfaction and stress. First, the model fit was found to be statistically significant at the level of F = 2.853, $p < 0.05$. Furthermore, as a result of controlling for demographic characteristics and including a variable for residential environment satisfaction, the explanatory power of stress was confirmed to be 5.5%. The level of residential environment satisfaction to stress was found to have a significant effect at the level of B = −1.151. Therefore, it can be inferred that as residential environment satisfaction increases, the stress of the elderly decreases.

Table 5 demonstrates the relationship among residential environment satisfaction, stress, and depression. First, the model fit was found to be statistically significant at the level of F = 26.434, $p < 0.001$. Moreover, as a result of controlling for demographic characteristics and including residential environment satisfaction and stress variables, the explanatory power of depression was confirmed to be 39.5%. Both residential environment satisfaction and stress had a significant effect on depression at the level of B = −0.204 and B = 0.080, respectively. Therefore, depression symptoms in the elderly decrease with increasing residential environment satisfaction and decreasing stress levels.

The significance of the mediating effect of stress was verified by bootstrapping. The results of the analysis showed that stress had a significant mediating effect, as 0 was not included within the 95% confidence interval (from −0.151 to −0.037) (Table 6).

TABLE 5 Relationship among residential environment satisfaction, stress, and depression.

Classification	Depression		
	coeff	se	t
Sex	−0.050	0.043	−1.15
Age	0.004	0.003	1.28
Education level	−0.088	0.050	−1.75
Family cohabitation	−0.113	0.048	−2.33
Residential environment satisfaction	−0.204	0.047	−4.36***
Stress	0.080	0.009	8.95***
Constant		2.310	
F		26.434***	
R^2		0.395	

***p < 0.001.
Dummy: Sex (1 = male), education level (1 = elementary school or above), family form (1 = cohabiting with family).

TABLE 6 Bootstrapping analysis results.

Path of mediating effect	Indirect effect	Confidence level	
		LCI	UCI
Residential environment satisfaction → stress → depression	−0.092	−0.151	−0.037

Conclusion

This study aimed to examine the mediating effect of stress on the relationship between residential environment satisfaction and depression in the elderly and to confirm a partial mediating effect. The obtained result is consistent with the result of previous studies reporting that the elderly's residential environment satisfaction has a direct effect on depression (7, 8), using stress as a mediator (15–18).

Based on these results, some practical and policy implications are suggested, as follows:

First, the government should actively utilize the concept of age-friendly cities proposed by the WHO in 2007 during the designing phase of urban planning. The key to an age-friendly city is to create a residential environment that is suitable for the elderly to live. For example, accessibility to large living facilities, such as transportation facilities, medical facilities, cultural facilities, social welfare facilities, and parks, used by the elderly should be considered. To this end, barrier-free walking and public transportation linking the elderly's residences and major living facilities should be implemented (7, 28).

Furthermore, it is necessary to design residential spaces considering the lifestyle of the elderly. For example, when remodeling or building an elderly residence, a universal design should be applied. In addition, the government should expand financial support for the installation of convenience facilities for the elderly during the planning of the universal design, focusing on elderlies with low-income. Furthermore, it is imperative to pay attention to the establishment of a community-level safety net that can offer protection from crime and disasters.

Also, one of the primary needs of the elderly is aging in place (AIP) (8). To meet this need, the government has already introduced a community care policy. As suggested above, for community care to be possible, maintaining social relationships in addition to ensuring a universal design of residential spaces and a barrier-free walking environment are major policy concerns. In other words, social relationships must be maintained to enhance the residential environment satisfaction of the elderly. Thus, policies promoting social participation activities and increasing the intimacy of the relationship with neighbors and family are necessary.

In contrast, stress was confirmed to have a mediating effect on the relationship between residential environment satisfaction and depression. Therefore, policy and practical considerations are necessary to help the elderly manage stress.

According to the Environmental Pressure Theory, environmental pressure induces negative emotions in the elderly (9). Also, depression is a negative emotional response that appears as part of the process of experiencing stress in the elderly. Previous studies (6, 13) indicated that constant exposure to acute or chronic stress may induce or cause a relapse of clinical major depressive disorder.

Therefore, to prevent the decrease in residential environment satisfaction from leading to an increase in depression, it is essential to effectively manage stress, a precursor to depression. In particular, while local community health centers and social welfare institutions are providing support to older adults with depression, stress management remains relatively insufficient. Therefore, it is necessary to devise a holistic system for stress management and depression in the elderly in the future. Moreover, the development of programs, such as leisure program, educational schemes and meetings that allow the elderly to gain a greater understanding of stress, must be performed in parallel (29–34).

Despite its significance, this study has several limitations. First, this study was conducted on a partial elderly population in Jeollanam-do; thus, our findings cannot be directly generalized to a larger population. Therefore, future research should be conducted on the elderly population nationwide. In addition, despite the existence of various mediating or moderating variables in the relationship between residential environment satisfaction and depression, only the stress factor was considered in this study. Therefore, it is necessary to include more diverse mediating or moderating factors in future studies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 13 October 2022
DOI 10.3389/fpubh.2022.993412

OPEN ACCESS

EDITED BY
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SPECIALTY SECTION
This article was submitted to
Public Mental Health,
a section of the journal
Frontiers in Public Health

RECEIVED 13 July 2022
ACCEPTED 30 August 2022
PUBLISHED 13 October 2022

CITATION
Khan W, Zahid RMA, Ullah I,
Chuadhry MA, Malik SY, Mughal YH,
Batool N, Begum A, Han H and
Mohamed A (2022) Impact of
COVID-19 on the wellbeing of micro
and small entrepreneurs of rural
Pakistan.
Front. Public Health 10:993412.
doi: 10.3389/fpubh.2022.993412

Impact of COVID-19 on the wellbeing of micro and small entrepreneurs of rural Pakistan

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According to the constitution of Pakistan, the state is responsible for the provision of necessities of life to its citizens whenever their livelihood is permanently or temporarily threatened. COVID-19 and its associated lockdowns were a series of events where amenities of life around the world were seriously endangered. Especially, hard hit were the small- and medium-sized entrepreneurs (SMEs) of rural Pakistan. To quantitatively assess the social and economic impact of COVID-19, we interviewed the local microenterprise owners in rural Pakistan from January to February 2021 and then June 2021. Mean comparison tests were estimated for pre- and post-COVID-19 periods. Results reveal that the COVID-19 pandemic has significantly and negatively affected wellbeing of micro and small entrepreneurs in the regions as the income of most of the sampled entrepreneurs significantly decreased during the pandemic. Disaggregated consumption analysis however revealed that nominal consumption of food, clothing, energy, health, and education all increased, except for communication, during the pandemic. Furthermore, the regression analysis revealed that changes in income, occupation, borrowing during COVID-19, and family type of the respondents were significant factors in mitigating the effects of COVID-19. Based on the findings, policy recommendations are also spelled out in the last section.

KEYWORDS

COVID-19 pandemic, social wellbeing, micro and small businesses, household expenditures, Pakistan

Introduction and background

In December 2019, the first case of COVID-19 was reported in Wuhan, China. The first case outside China was reported on January 13 in Thailand (1), and by the end of January 2020, the total number of COVID-19 infected cases reached an overwhelming 7,819 people spread throughout the entire world (2, 3). According to the latest

statistics available (May 18, 2022), the total number of cases in Pakistan stood at more than 1.5 million people, causing a total of more than 30,000 deaths (4). To slow down the spread of the pandemic, Pakistan imposed lockdowns in March 2020, which were subsequently eased in May 2020.

Besides health, COVID-19[1] has severely affected businesses around the globe, especially in developing countries (5, 6). During COVID-19, the global Gross Domestic Product (GDP henceforth) declined for the first time in more than 25 years (7). The GDP of India declined the most (23.9%), followed by the Eurozone (12.1%), Brazil (9.7%), United States (9.5%), and Japan (7.8%). During the same period, the growth in Pakistan's GDP declined to 1.4% (7). The economic downturn during this period pushed many people around the world below the poverty line. For instance, a simulation analysis by Sumner et al. (8), covering 138 low-income and 26 high-income countries, estimated that COVID-19 could drive another 85 million into poverty (8, 9). These predictions are empirically proved correct by many studies from around the world [see for instance (10, 11)].

The negative economic impacts of COVID-19, although generally severe, were not equally distributed across sectors and job types. The likelihood of losing their jobs was the greatest for non-permanent employees (5) and the likelihood of slipping below the poverty line was the greatest for self-employed people (10). Likewise, sectors connected with international trade and tourism (such as accommodation, food services, and transportation) suffered the most as compared to agriculture and construction (10). Moreover, as reported by Sonobe et al. (5), the negative impacts of COVID-19 on countries also varied with their level of national income. Countries dependent on micro, small, and medium enterprises (MSMEs henceforth)[2] for the bulk of employment generation and having a lower level of national income are likely to be the hard hit in terms of negative economic consequences of COVID-19. MSMEs usually have less control over resources and are more exposed to shocks (13, 14).

Early research shows that the lockdowns associated with COVID-19 harmed 58% of the medium-sized, 65% of the small, and 69% of the micro-sized firms (15). Likewise, Pedauga et al. (16) reported that MSMEs explained 62% of the employment reduction in Spain due to COVID-19-related lockdowns. The negative effects are however not only transitory but may lead to bankruptcy (17) and market exits (18) for some of the business firms. MSMEs are the leading employment provider sector in Pakistan, which represent an estimated 90% of all business and contribute 40% to GDP and the country's export (19). Statistics show that COVID-19 has significantly affected the economic activity in Pakistan (7, 20) but less is known about how the negative consequences of COVID-19 on MSMEs translated into reduced welfare at the rural level[3].

Foregoing in view, the current study is carried out to understand the negative economic impact of COVID-19 on small entrepreneurs in rural Pakistan. To the best of our knowledge, this is the first attempt to study the impact of COVID-19 on micro and small entrepreneurs' wellbeing in this region. The rest of the paper is organized as follows: Section Relevant literature, theoretical framework, and hypothesis development discusses the relevant literature, develops a theoretical framework, and deduces a testable hypothesis. Section Research design of the study outlines the research design, data, and analytical methodology of the study. Section Results and discussions presents results and analysis, while Section Conclusion and policy implementations concludes the study and presents policy recommendations.

Relevant literature, theoretical framework, and hypothesis development

With the onset of COVID-19 and its associated lockdowns, the logistics and supply chain management disruptions were the foremost to be experienced by MSMEs (15). About half of the MSMEs experienced delays in the delivery of services and products and an unprecedented demand deficiency [see for example (15, 21)]. Since lack of demand affects MSMEs the most as compared to large firms (16), the majority of the MSMEs owners reported lack of customers as the most negative economic outcome of the COVID-19-related lockdowns (11, 22).

Deficient aggregate demand resulted in no/less sales and revenues for the MSMEs. For instance, Shinozaki and Rao (21) reported education- and construction-related firms with no sales during March 2020 in the Philippines to be 47.9% and 39.8% higher as compared to agriculture-based firms. Consequently, revenues of the MSMEs also followed the same path [see (18, 23)]. On the other hand, supply disruptions caused the cost of production for MSMEs to increase (22), resulting in reduced profits somewhere (22, 24) and in financial and accounting losses elsewhere (17, 25).

1 Covid-19 is the disease caused by the virus known as SARS-CoV-2. SARS-CoV-2 spread was reported in late 2019 in Wuhan, China, and has since spread all over the world.

2 Micro and Small, and medium enterprises (MSE): According to SBP (12), micro-enterprises are those firms that have less than 10 employees (excluding seasonal labor), while small enterprises are those having up to 50 employees, including contractual employees and an annual turnover of PKR 150 million. Medium-sized enterprises are categorized business-wise; first, manufacturing and service have employees (51–250) and annual sales turnover of over PKR 150–800 million. Second, trading has 51–100 employees and an annual sales turnover of over PKR 150–800 million.

3 Approximately, 70% of Pakistan's population still lives in rural areas.

To minimize losses, the MSMEs natural response was to either completely shut down (18, 22) or to downsize production (16) by laying-off workers. Since employment predominantly depends on MSMEs (16), downsizing resulted in massive unemployment around the world. Other loss-minimizing strategies adopted by MSMEs during COVID-19 included forced unpaid leaves and reduced wages (14, 21, 25–27). Consequently, incomes of both the employer (due to demand deficiency and cost-push-induced reduced profits) and employees (due to unemployment, forced unpaid leave, or reduced wages) decreased, resulting in increased poverty (10, 28). The net effects of all such developments during COVID-19 resulted in reduced livelihood expenditure (22) and food insecurity (29, 30).

The theoretical framework, based on the early findings of the COVID-19 era empirical research and Keynesian economics, is detailed in Figure 1. This enables us to deduce the testable hypothesis that COVID-19 has a significant negative impact on the income of the economic agents, and in the absence of any intervention, the reduced income must translate into reduced household expenditure and welfare[4].

Research design of the study

Area profile and sampling

District Dir (Lower) has 1.436 million people (Cense report 2017). The district has six tehsils that have 34 union councils. Out of the total population of the district, 0.31 million are active laborers. Agriculture accommodates about 40% of the labor force (31), while only 12% are self-employed. About 40% of the district labor force are wage earners.

Human capital with good education and sound health contribute substantially to the development of a society. Statistics show that Pakistan's health sector is lagging far behind the rest of the world. According to Pakistan's demographic health survey report (2012–2013), the child mortality rate is 74 out of 1,000; malnutrition in children under age 5 is 24% and only 34% of the women attend health facilities during birth. The situation in Khyber Pakhtunkhwa is even worse. According to PSLM (32), about 78% of children need treatment for diarrhea and 14% of women do not visit any medical facility during pregnancy. COVID-19 further increased stress on the already weakened health system of Pakistan and especially on the health facilities in rural areas (33).

4 According to Friedman's permanent income hypothesis (1957), transitory income changes should not change consumption and welfare. But given the uncertainties associated with the Covid-19 outbreak, changes in income during that period could not be considered transitory changes.

Sampling and data collection

Data regarding the number of small and medium enterprises in the province is not objectively known. According to some estimates [see for example (34)], the number of troubled small and medium enterprises is approximately 2,504 in the province, still, the overall number is not known. The district where the study is conducted is a tax-free zone and there is no registry of the small and medium enterprises in the district that could be used as a sampling frame. Consequently, the study uses a convenient and purposive sampling framework. Overall, data has been collected from 303 entrepreneurs engaged in business related to agriculture, forestry, mining, services, manufacturing, construction, storage, transport and communication, real estate and rental, and retail business. Respondents belong to three tehsils and 18 union councils, as shown in Table 1. A structured questionnaire with close-ended questions, adapted from Khan et al. (35), is used for data collection (Appendix).

Analytical framework

The data is analyzed using frequencies, descriptive statistics, and independent sample t-test for before–during comparisons to assess the welfare consequences of COVID-19. Subsequently, various consumption heads are used as dependent variables to know how variations in income, occupations, family type, business age, working hours, and borrowing during COVID-19 mitigated the welfare consequences of COVID-19. More formally, let CFE_{it} be changes in food expenditure of the ith MSME owner at the tth time (t = either B or D, where B refers to time before COVID-19 and D refers to time during COVID-19), CII_{it} be changes in income, BDC_i be borrowing during COVID-19 (= 1 if the owner borrowed money during COVID-19 and 0 otherwise), ABY_i be the age of the business at the time of data collection, CIO_{it} be changes in occupation during COVID-19, CWH_{it} be changes in working hours, and FT_{it} be the family type (= 0 if joint family and 1 if nuclear family) of the ith MSME owner. Then a regression model can be specified as;

$$CFE_{it} = \beta_0 + \beta_1 CII_{it} + \beta_2 CIO_{it} + \beta_3 CWH_{it} + \beta_4 BDC_i + \beta_5 ABY_i + \beta_6 FT_i + U_{it} \quad (1)$$

Dependent on the error structure specified in equation (1)[5], the study estimates a set of six such equations. Multicollinearity will be checked using the correlations matrix while heteroskedasticity and autocorrelation, respectively, will be checked using the White's (36) and Durbin-Watson tests.

5 If the error structure satisfies the usual assumptions of classical linear regression model, the equation can be estimated using the Ordinary Least Squares method and the resulting estimates are BLUE.

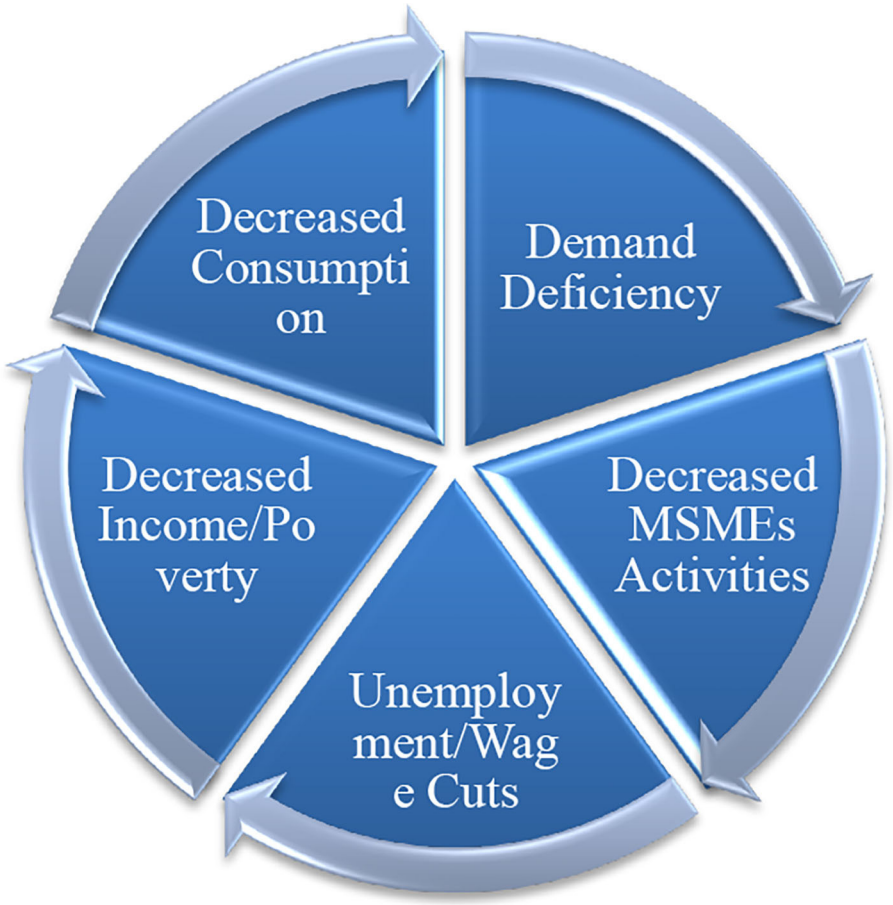

FIGURE 1
Theoretical framework of the study.

Results and discussion

Frequencies obtained from the data show that about 81 of our sampled respondents live in a joint family while the rest (19%) lives in nuclear families. Approximately, 90% of the respondents did not switch their jobs/businesses during the study period but 58% of them resorted to debt financing for running their activities and meeting household obligations. Interestingly, those who looked for alternative jobs/income sources were predominantly in the services (barbers and tailors) and agriculture sectors. As is shown in Table 2 (also see Table 3), however, the majority of the sampled respondents experienced a drop in their income level due to COVID-19.

The theoretical framework developed in Section Research design of the study implies that the negative economic consequences start with supply shocks and demand deficiency. The results outlined in Table 3 show that, on average, the working hours of the MSMEs have reduced from the pre-COVID era of 8.65–8.17 h, showing the slowing down of the rural economy of the area under consideration. Resultantly, incomes of the sample respondents also decreased but contrary to the postulation of the theoretical model, expenditure on most heads (except communication) showed an increasing trend. That is, Levene's and independent sample t-tests confirm that working hours and income significantly reduced during COVID-19, but expenditure on food, clothing, energy, and education significantly increased during the same period. Expenditure on health and communication, although changed, is, however, statistically insignificant during the study period. These apparently divergent results are further discussed once the influence of the mitigating factors on variations in consumption (Table 4) during COVID-19 is considered.

The estimated regression results, based on variants of equation (1), are outlined in Table 4. Note that the correlation matrix of the mitigating/explanatory variables is not reported but none of the bivariate correlation coefficients exceeded 0.3 in absolute terms. Besides, the variance inflating factors (centered) are reported in Table 4. Hence, there is no issue of

TABLE 1 Union council-wise distribution of the sample units.

Union councils	Sampling units	Tehsil	Sampling units	District	Sampling units
Ouch	22	Adenzai	172	Dir lower	303
Kotigram	23				
Khanpur	12				
Tazagram	61				
Asbanr	8				
Chakdara	32				
Badwan	6				
Khadagzai	8				
Temergara Urban	14	Temergra	63		
Khungai	8				
Bandagai	9				
Bagh	11				
Talash	12				
Noorakhel	9				
Koto	8	Balambat	68		
Lajbook	22				
Munjai	17				

TABLE 2 Income distribution before and during COVID-19 (Unit: Pakistani Rupee).

	Before COVID-19		During COVID-19	
	Frequency	Percentage	Frequency	Percentage
20,000 or less	1	0.33	18	5.94
21,000–25,000	10	3.3	27	8.91
26,000–30,000	32	10.56	28	9.24
31,000–40,000	99	32.67	111	36.63
41,000–55,000	100	33	57	18.81
56,000–70,000	24	7.94	48	15.84
71,000–85,000	31	10.23	10	3.30
86,000 or above	6	1.98	4	1.32

multicollinearity in the regression. Moreover, the R^2 and the F-test associated with each regression implies that the inclusion of the mitigating factors significantly improves the fit of the model in comparison to an intercept-only model[6]. Although R^2 associated with these models are relatively low, these are normally in the acceptable range (37).

The Durbin-Watson d-statistics values are in the acceptable margin (except when variations in consumption on communication is used as a dependent variable), implying that there is no issue of serial/autocorrelation. Likewise, heteroskedasticity is found only in the food consumption and communication regressions. The two models are therefore estimated using the heteroskedasticity and autocorrelation (HAC) robust standard errors.

The results outlined in Table 4 are generally in line with prior research. To save space, we only discussed the significant results outlined in Table 4. As postulated in the theoretical model, changes in income are positively related to variations in food consumption. Changes in working hours, occupation, and borrowing, although positively influencing food consumption, are all insignificant statistically. Family type (living in a nuclear family), however, influences food consumption negatively. This result is in line with Galeana et al. (24) and Dagpin et al. (18), to whom family works as a shock absorber during negative shocks like COVID-19. Since people living in joint families have shared responsibilities, as well as their sources of income may also be diverse, hence entrepreneurs living in nuclear families are at a disadvantage in such times.

Consumption of clothing is however influenced only by changes in occupation and borrowing during COVID-19. Although there were very limited opportunities for alternative income sources during COVID-19, prior research has reported that approximately 9–32% of business owners in South Africa were able to generate alternative incomes during COVID-19 (25)[7]. As mentioned in the starting paragraph of this section, those who looked for alternative income sources were predominantly from the services sector (barbers and tailors) whose businesses were strongly dependent on interactions with others and could have caused spreading the disease to others. Hence, their businesses were more affected, and they looked for alternative jobs. Energy consumption (firewood, electricity, fuel, and gas) was however negatively influenced by changes in income, age of the business, and borrowing during COVID-19. This may be because food consumption was essential for survival and may have crowded out other consumption during the period. That is, whatever slight increase in income or borrowing occurred during that period was solely devoted to food consumption.

Variations in expenditure on health before and during COVID-19 were positively influenced by a change in occupation but negatively by borrowing during COVID-19. Variations in expenditure on communication, on the other hand, were positively influenced by income and negatively by working hours and change in occupation. While the impact of income and occupation on expenditure on communication is standard, the negative impact of increased working hours on communication expenditure is paradoxical. Last, although the fit statistics warrant a poor fit, variations in education expenditure before

6 When treating changes in education as a dependent variable (the only case in the six regressions), the F-value is insignificant, implying that the model provides no improvement in comparison to an intercept only model.

7 The alternatives included selling masks, food items and helping elderly and those in quarantine due to Covid-19.

TABLE 3 Mean differences before and during COVID-19.

Variable(s)	Mean (before COVID-19)	Mean (during COVID-19)	Mean Difference	Levene's Test[a]	*t*-test
Age of business	NA	6.6	NA	NA	NA
Working hours	8.65	8.17	−0.488	2.804	3.579*
Income	46,641.91	42,481.85	−4,160.07	0.178	3.258*
Expenditure on food	16,940.59	20,488.45	3,547.86	31.11*	−5.129*
Expenditure on clothing	2,894.06	3,616.5	722.44	5.82**	−3.34*
Expenditure on energy	5,990.43	6,956.11	965.68	4.04**	−1.91**
Expenditure on health	2,500	2,714.85	214.85	2.28	−1.18
Expenditure on communication	993.73	984.82	−8.91	2.80	0.20
Expenditure on education	2,601.32	3,441.91	840.59	4.86**	−5.67*

*$p < 0.01$, **$p < 0.05$.
[a]The Levene's statistic tests the hypothesis that the two samples (before and during COVID samples) have equal variance. The t-test value then depends on whether the null hypothesis of equal variance is rejected or accepted. The last column of the table hence reports the relevant t-statistic.

TABLE 4 Mitigating factors of consumption during COVID-19.

Mitigating factors		Variations in consumption on					
	VIF	Food	Clothing	Energy	Health	Communication	Education
Change in income	1.06	0.067*	−0.002	−0.043**	−0.02	0.003**	0.006
Change in working hours	1.03	133.48	56.74	92.03	−110.69	−47.25*	80.47
Change in Occupation	1.02	1.33	1,186.4*	849.72	1,385.1*	−277.26*	−86.18
Borrowing during COVID-19	1.11	531.23	598.61*	−1,337.4*	−514.5**	35.55	−189.4
Age of business	1.14	−30.07	43.26	−172.51*	3.97	1.002	−12.14
Family type	1.03	−2,240.8*	−124.42	−666.55	173.97	8.49	−626.97*
Intercept		5,992.8*	−374.11	4,584.8*	455.45	−58.52	2,011.51*
R^2		0.054	0.054	0.068	0.062	0.16	0.032
F-statistics		2.78*	2.86*	3.60*	3.29*	9.19*	1.6
Durbin-Watson d-statistics		1.85	1.92	2.15	1.99	1.5	1.74
White's statistics[a]		11.71**	5.89	5.46	6.45	25.95*	7.46

*$p < 0.01$, **$p < 0.05$.
[a]The null hypothesis of the White's general heteroskedasticity is that the errors are homoscedastic. In case of rejection of the null hypothesis, heteroskedasticity and autocorrelation robust standard errors, and the corresponding t-ratios, are estimated.

and during COVID-19, according to the results, depended only on the family type. Again, MSMEs owners living in nuclear families reduced their expenditure on education, as compared to those living in joint families, during the COVID-19 era.

Before closing this section, the results outlined in Table 3 showed that working hours and incomes of the MSME owners significantly decreased during COVID-19 but consumption of food, clothing, energy, and education increased during the same period. Although it is logical in the circumstances that some of the expenditure may have increased[8], these apparently counterintuitive results may be because the study considers nominal values of the variables under consideration. According to Planning Commission of Pakistan reports (May and July 2021), prices of food items and energy increased by double digits during the period under study. Accounting for this much inflation would further decrease the real value of income. An increase in real consumption may also be negative during the same period if inflation is taken care of. Indeed, prior research has also shown that supply-related disruptions resulted in cost escalations around the world [see (15, 22)]. The net economic effects of COVID-19 may even be more severe on the welfare of the MSME owners if cost escalations are made part of the calculus.

The other counterintuitive result relates to the impact of borrowing on various expenditure heads (38). Specifically, the results show that borrowing during COVID-19 increased

8 This may be true as most of the family members remained in homes during lockdowns, which might have increased demand for food and energy.

expenditure on clothing but those on energy and health were decreased. Since it has been already stated that none of the MSMEs in the area are registered because the area under study is a tax-free zone. But being unregistered also implies that these MSMEs cannot resort to formal credit sources for financing their needs. Consequently, informal sources of credit are tapped in times of emergencies. Hence, it is quite possible that during the study period, the respondent may have experienced no health emergency. The credit taken by the respondents might have been used elsewhere, such as a cultural, social, or religious obligation. It is also quite possible that credit from one informal source during COVID-19 is obtained to pay back another informal source from whom credit in an earlier time is obtained.

Conclusion and policy implementations

Prior research from around the globe has shown that COVID-19 and its associated lockdowns have devastating economic effects on the masses. Especially hard hit, according to the research, are the MSMEs and areas that are less economically privileged. To assess the economic impact of COVID-19 on the owners of MSMEs in rural Pakistan, we have collected data from 303 owners spread over three tehsils of district Dir Lower of Khyber Pakhtunkhwa, Pakistan. The data were then analyzed using descriptive statistics and rigorous regression analysis.

The results show that, as in other geographical regions of the world, working hours and nominal incomes of the MSME owners were reduced significantly by the onset of COVID-19 and its associated restrictions. Paradoxically, it was found that nominal expenditure on food, clothing, energy, health, and education increased and those on communication decreased during COVID-19. Given that inflation in Pakistan was in double digits, it may be the case that the real value of income and consumption and the associated wellbeing may be lower than estimated. But if these values are considered as they are, then in line with previous research [see (21, 25)], the MSME owners may have dipped their savings or retained profits to smoothen their consumptions. Again, this interpretation is welfare reducing as such developments will harm their businesses in the longer run.

Moreover, this study also found that variations in income caused positive changes in the consumption of various food items. Likewise, variations in working hours have also positive effects, although insignificant, on most of the consumption items. Informal borrowing during COVID-19 increased consumption of clothing, food (insignificantly), and communication but reduced consumption of energy and health, this may be due to the nature of the "informal" borrowing. These findings have important policy implications for coping with the negative economic consequences of emergencies like COVID-19.

Since the theoretical framework and the findings of the study are very much in line with Keynesian Economics, the policy implications also are of the Keynesian type. And indeed, many countries like the USA, China, and Pakistan followed such policies during COVID-19. Loans are waived off to support micro-, small-, and medium-sized enterprises considerably. But, given that the MSMEs in the area under study have no access to formal credit during the study period, it is recommended that the MSMEs should be brought under the formal credit nets to help them in times of emergencies. Moreover, MSMEs around the world benefited from online sales and digitalization during COVID-19. To continuously reap the employment generation benefits of the MSMEs in Pakistan, the owner must be trained in digitalization and online sales of their products.

Before closing the study, there are several limitations of the study that needs to be mentioned. First, the sample consists of micro and small entrepreneurs working in lower Dir Khyber Pakhtunkhwa, Pakistan. Future studies may include entrepreneurs from other districts and provinces to accurately understand the negative impact of COVID-19 on micro and small businesses. Second, the assessment in the instant study is solely based on quantifiable parameters. Future research can add psychological, environmental, and social impacts to get a holistic view of the COVID-19 impacts. Third and most importantly, the study does not capture the gender aspect of COVID-19's impacts on SMEs. Recently, it has been that women-led MSMEs faced more serious impacts than men-led MSMEs (21) and that such MSMEs were less likely to receive public support (39). MSME's ownership is predominantly in the hands of men in the study area, but future research must not ignore this gender aspect of the impacts of COVID-19.

Fourth, the study relied on the memory of the respondents for information. Since the two time periods were 6 months apart, there may be an element of memory decay in the information provided. Likewise, given the expectations of MSME owners in times of emergency, it is quite possible that the owner might have understated their incomes and overstated their consumption. Future researchers are advised to adopt novel data collection techniques to overcome such limitations.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

RZ, WK, and NB contributed to conception and design of the study. SM and AB organized the database. RZ

and IU performed the statistical analysis. WK wrote the first draft of the manuscript. YM, HH, MC, and AM wrote literature sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

Funding

This project was partially financed by the University of Baltistan, Skardu, project number UOBS-ORIC/Covid-2020/004.

Acknowledgments

We are thankful for all the participating micro and small entrepreneurs, who, despite COVID-19-related restrictions, participated in the study. We are also thankful to Mr. Abdul Samad and Mr. Abrar Khan, BS students at the Department of Economics, the University of Malakand for their help in finding relevant literature.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.993412/full#supplementary-material

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 28 October 2022
DOI 10.3389/fpubh.2022.1031520

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

RECEIVED 30 August 2022
ACCEPTED 11 October 2022
PUBLISHED 28 October 2022

CITATION
Li Z, Du N, Wang B and Oteng-Darko C (2022) Impact of social influence on users' continuance intention toward sports and fitness applications. *Front. Public Health* 10:1031520. doi: 10.3389/fpubh.2022.1031520

Impact of social influence on users' continuance intention toward sports and fitness applications

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The purpose of this paper is to explore how social influence (SI), which is disaggregated into subjective norms (SN), social image (SIM), and social identity (SID), predicts perceived usefulness (PU), perceived pleasure (PP), and continuance intention (CI) toward sports and fitness applications. The underlying context is the socialization and gamification of exercise during the Covid-19 pandemic. Based on the theory of SI and the technology acceptance model, a theoretical framework was built where PU and PP mediate the influence of SI on CI, and proposed hypotheses were tested. The responses of 296 Keep users (a popular sports and fitness application in China) to a questionnaire survey were analyzed. SN and SIM were found to have significant positive effects on SID; SID has significant positive effects on PU and PP; both PU and PP have significant positive effects on the CI of users; SID and PU positively and significantly mediate the relationship between SN/SIM and CI; PU positively and significantly mediates the SID-CI relationship. However, the role of PP in mediating the influence of SI on CI is non-significant. This paper deepens the current understanding of the mechanisms that influence the relationship between SI and CI under the context of socialization and gamification services.

KEYWORDS

social influence, continuance intention, sports and fitness application, perceived value, perceived pleasure

Introduction

Today's lifestyle is becoming increasingly sedentary, which causes a rapid increase in the prevalence of ailments like cardiovascular problems, diabetes, and obesity. Most of these chronic diseases can be avoided by making lifestyle changes that include regular exercise and participation in sports. People typically have the tendency to focus on short-term rather than long-term rewards in their daily life (1). This often leads to the attempt to abandon physical exercise when short term results cannot be achieved from sports and fitness activities. As a result, individuals require sustained motivation to engage in physical activity.

Previous studies have shown that socialization services, particularly virtual communities (2) and gamification services (3–5), can encourage users' continued intention. Sports and fitness applications that offer gamification and socialization services are derived from this. They encourage users to participate in long-term activities by giving them short-term objectives, incentives, encouragement, and access to virtual communities. Virtual communities are also known as social networks that are interactive in nature and create a platform for users. The operation of websites has evolved in today's Web 2.0 era, and social media communities serve as the primary focus of development (6, 7). Businesses and other organizations use these virtual communities to market their brands, with associated fan sites becoming very prevalent. By providing engaging and copious content, as well as continued, uninterrupted interaction, the administrators of virtual communities try to draw more users and raise the market profile of the associated businesses.

Sports and fitness platforms are becoming increasingly homogenous, making it challenging for most users to assess the quality of such platforms. The role of social influence (SI) is becoming increasingly prominent. When predicting continuance intentions (CI), especially in the context of gamification, SI is vital (4), and the importance of the social aspects of sports gamification have been highlighted (6, 8). The number of available technological approaches that utilize SI and related psychological phenomena to steer human behavior toward sustainable, healthy, and otherwise beneficial behaviors is growing. However, research-based knowledge on whether these technological solutions with social features can actually motivate people to pick up and continue with encouraged behaviors is scarce.

The objective of this study is to explore the underlying process of the relationship between SI and users' CI toward sports and fitness applications. In this paper, several research gaps of previous studies on the role of SI in shaping users' CI are addressed. First, the interdisciplinary basis of SI across multiple research disciplines has led to the emergence of various conceptualizations with various labels and meanings (9). Researchers have coined a variety of terms to describe potential SI mechanisms associated with the adoption and continual use of technology. These include critical mass (10), perceived network externalities (11, 12), subjective norms [SN; (13)], group norms, and social identity [SID; (14, 15)], among others. These different terms reflect the conceptual complexity and heterogeneity of SI (16). As a result, most previous studies considered SI as a whole or lumped it under terms such as "social influence" or "social norm" to explain users' continuance behavior (4, 17). However, the underlying motivations, decision rules, and social processes differ both conceptually and theoretically (18). In this context, the concept of SI should be explained through a more clearly defined and appropriately tested subordination structure.

Second, previous studies focused on the relationship between SI and CIs through the mediating role of perceived value (17). How the role of different conceptualizations of SI work with perceived value to affect users' CI has not been explored so far. In the context of gamification and socialization services, this lack of knowledge calls for research that disaggregates SI to better understand how various conceptualizations of SI affect users' CI.

To fill this gap in the literature, first, SI was disaggregated into three different conceptualizations based on social influence theory (SIT). Particularly, SN are the primary conceptualization of SI. Several earlier studies conceptualized SI by viewing it as an identification process based on SN. To explain identification, two categories of conceptualization were employed by scholars: SID-related constructs [i.e., (19)] and social image (SIM)-related constructs [i.e., (6)]. Users can participate more actively in the virtual community and maintain active connections with other members because of the SID of the community (20, 21). Users are encouraged to continue participating in the virtual community because joining the virtual community improves their image and status (6). Therefore, in this study, SN, SID, and SIM are employed to represent SI.

Second, this paper examines how the conceptualization of SI works with perceived value to shape users' CI based on the technology acceptance model (TAM). Taking into account the function of sports and fitness application during the pandemic period, perceived value is represented by perceived usefulness (PU) and perceived pleasure (PP). They are incorporated into the theoretical framework to serve as the mediators in the relationship between the different conceptualizations of SI and users' CI.

This paper is organized into six sections, of which the Introduction is the first. Related theory, literature review, and research hypotheses presents the related theory, a succinct literature review, and hypotheses development. The methodology of the study is presented in Materials and methods. Results presents the results obtained. Discussion and conclusion provides a discussion and conclusions, and limitations and future research are provided in Section 6.

Related theory, literature review, and research hypotheses

Social Influence theory

The theory of how other people or organizations can affect people's behavior is explained by SIT. Venkatesh et al. (22) defined SI as "the degree to which an individual perceives that important others believe he or she should use the new system." In recent years, SIT has been used to explore how people use information technology or systems, an approach that was first introduced by Davis (23). Venkatesh and Morris (24) examined gender, SIs, and how these factors affect people's acceptance

and use of technology. Vanduhe et al. (4) combined task technology matching and social motivation to predict whether employees would accept gamification for training. Singh et al. (25) examined the impact of usage pressure, SI, and innovation effects analysis on the acceptance and recommendation of mobile wallet services.

Scholars have combined different theories to explore the relationship between SI and continued use of technology. However, the interdisciplinary basis of SI has led to various conceptualizations with different names and meanings, such as SN, group norms, SIM, and SID (22). These starkly different interpretations of SI pose a challenge for technology continuance usage research. It was very common for SN to be primarily conceptualized as SI (26). Many scholars have explored the relationship between SN and continuance use (27–29). In recent years, scholars began to conceptualize SI through SID and SIM (30, 31). In extension of this trend, this study conceptualizes SI through the three conceptualizations of SN, SID, and SIM.

SN refers to the perceived social pressure to perform or not to perform certain behaviors (32), mainly in view of what others expect. SID is the sense of belonging to and identification with a community and includes pride of being part of that community (33). Tajfel et al. (34) first proposed the theory of SID and defined "social identity as that part of an individual's self-concept which derives from his knowledge of his membership of a social group (or groups) together with the emotional significance attached to that membership." In other words, SID refers to the individual's sense of identity relative to the group. Boulding (35) suggested that human image can convey a person's behavior, which reflects the subjective concept a person possesses. Moore and Benbasat (36) pointed out that image is the degree to which a person perceives that using innovation can improve their image or status. The concept of image can be applied to different fields, such as brand image, enterprise image, etc.

Technology acceptance model

Based on the theory of reasoned action, Davis (23) developed the TAM. Davis indicated that the most crucial personal perceptions about using information technology were PU and perceived ease of use. PU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance." Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort." In the information systems field, the TAM has been widely used to study the adoption of various technologies. Thereafter, Venkatesh and Davis (37) developed the TAM2 by adding SI and cognitive instrumental processes to predict the adoption of a certain information technology.

When a system is perceived as useful, persons tend to overcome the difficulty associated with its use to obtain the benefit its use promises (38). This suggests that PU may be a more important factor than perceived ease of use. Particularly, many studies highlighted the role of PU when analyzing users' CI toward health-related applications (17). In addition to PU, scholars suggested that PP is an equally important factor (17, 39, 40). Additionally, perceived enjoyment (i.e., pleasure) was integrated into the TAM and proven to be an important predictor of the continuance usage of health-related applications (41). Huang and Ren (42) recently suggested that people with low self-efficacy may place a higher value on entertainment features, such as gamification and social networking features. In summary, people with low self-efficacy may need an extra push to facilitate their self-regulation mechanisms to engage in physical activity regularly. More and more fitness applications are focusing on gamification and social applications, competition, achievements, and upgrades. In this context, this paper retains PU and PP to explain the users' CI.

Hypotheses development

Subjective norms and social identity

Previous studies have demonstrated the connection between SID and SN. For instance, Terry et al. (43) found that the intention of people who strongly identify with a reference group to perform a certain behavior was influenced by perceived group norms. Thorbjørnsen et al. (44) suggested that SN positively influence SID. A customer will be more motivated to express particular ideas about the values and identity of in-group members if those beliefs are made more salient and/or if the drive to uphold those beliefs is strengthened. Reed (45) found that consumers are more likely to be influenced by SN when their SID is highly prominent. Therefore, the following hypothesis is proposed:

H1: *SN has a positive effect on SID.*

Social image and social identity

In addition to the expectations of significant others, the interactions with members of online sports and fitness communities also provide social benefits. Members' socialized participation is basically established in two ways: unilateral contributions as part of building one's reputation, and bilateral knowledge exchange for reciprocal behaviors (46). These rewards aid a person in identifying themselves as an in-group member or community opinion leader if the sharing of information and experiences increased their status and reputation. Helping others and exchanging information have such beneficial effects because of the sense of reciprocity associated with them (47). Previous studies have shown that SIM impacts SID (48). Users who believe that using sports and fitness applications will improve their status or image from the perspective of others also believe that this will result in favorable feedback from others about their behavior. Such favorable

feedback further strengthens the users' identification with the community. Therefore, the following hypothesis is proposed:

H2: *SIM has a positive effect on SID.*

Social identity, perceived usefulness, and perceived pleasure

Song and Kim (3) first proposed that SID is a key determinant of the intention toward a particular technology or system in a virtual community service environment. Kwon and Wen (49) pointed out that SID significantly impacts user perceptions such as PU and perceived encouragement. Individuals with greater recognition in their communities will be more willing to participate and share information in online communities to continue using the system. Furthermore, Murray and Sabiston (50) suggested that SID is a predictor of PP because fostering SID with one's sport team may contribute to greater enjoyment of sports. In sports and fitness applications, individuals gain recognition from acceptance and compliance to SIs, thus gaining emotional experiences such as PP (51). Therefore, the following hypotheses are proposed:

H3: *SID has a positive effect on PU.*

H4: *SID has a positive effect on PP.*

Perceived usefulness, perceived pleasure, and continuance intention

Motivational theory is frequently used to explain how people behave when accepting information technology. Davis et al. (52) found that both extrinsic (usefulness) and intrinsic (pleasure) factors influence the motivation to use systems. In addition, many scholars have found that both intrinsic motivation (pleasure) and extrinsic motivation (usefulness) affect an individual's intention to use information technology (53, 54). If an individual perceives a system as useful, this individual will actively use it. Research confirmed that users' PU has a positive effect on the use of information technology (55–58).

PP is an important factor in motivating users to use new technologies (52, 59, 60), especially hedonic systems (52, 54, 61, 62), where individuals engage in a certain activity for pleasure (62). In fact, PP is part of all performance consequences of technology use, defined as the extent to which the use of technology itself is considered pleasurable (61–64). Users are more likely to repeatedly utilize an application when they are satisfied with it (39). Therefore, the following hypotheses are proposed:

H5: *PU has a positive effect on CI.*

H6: *PP has a positive effect on CI.*

Social identity and continuance intention

SID helps users to actively interact and participate with other members of shared social network groups (14, 20, 65). Song and Kim (3) identified SID as a key factor influencing the intention to use a particular technology or system in online activities. More specifically, Vanduhe et al. (4) found that PU is a significant mediator of the effects of social recognition and SI on CI. If individuals had higher recognition of their communities, they will have greater willingness to participate and share information in online communities (48). Perceived usefulness has the potential to mediate the effect of social identity on persistent intentions. Murray and Sabiston (50) found that enjoyment (pleasure) mediates the relationship between SID and the cessation of sports activities. This is similar to the context of continuous exercise and fitness application use, where PP may play a mediating role. Therefore, the following hypotheses are proposed:

H7: *The effect of SID on CI is mediated by PU.*

H8: *The effect of SID on CI is mediated by PP.*

Subjective norms and continuance intention

The personal cognitive behavior of consumers is affected by the virtual communities and peers they engage with (66). Consumers will be persuaded to join the community and use the sports and fitness system by their peers if they anticipate that their peers will also use the platform. According to the theory of rational action, the behavioral intentions of individuals are influenced by SN (65). Furthermore, SN has implications for individuals' intention to use information technology (67, 68). In addition, SN is also assumed to be an important determinant of the CI to use certain systems. Studies have shown the effect of SN on the prolonged use of instant messaging (14). To lower the predicted risk, users are more mindful about other people's conduct or opinions in a network setting that contains numerous unknown aspects. As a result, SN has an even stronger impact.

However, this effect is not apparent. Reed (45) found that consumers are more likely to be influenced by SN when their SID is highly prominent. SID mediates the effect of SN on intention (69, 70). Chen et al. (71) found that social identity plays an essential intermediary role in the participation mechanism. Moreover, perceived value is a significant mediator of the effects of SI on CI (4). For example, Vanduhe et al. (4) found that perceived usefulness is a significant mediator of the effects of reputation, social recognition and social influence on continuance intention. This means that the influence of SN on intention is mediated by SID and PU/PP. Therefore, the following hypotheses are proposed:

H9: *The effect of SN on CI is mediated by SID and PU.*

H10: *The effect of SN on CI is mediated by SID and PP.*

Social image and continuance intention

The desire to increase one's social status is a significant cause for people employing innovative technologies (72, 73). People adopt innovative technologies and build social differences by

developing their SIM (74, 75). Therefore, one of the potential benefits of using sports and fitness applications is gaining positive SIM. Previous studies have uncovered a positive correlation between SIM and CI (6, 76). Only when users believe that using a certain system will improve their status and image, they will participate more actively (6).

SI impacts users' CIs through perceived value (77). When users get more attention and positive feedback from the community, they will slowly accumulate fans, which will undoubtedly enhance the users' status in the community as these communities are driven by their fan/follower bases. When users have a large number of fans, they feel a stronger sense of belonging to the community, and the joy they perceive from the large number of fans prompts users to continue using the system and become involved more actively. Therefore, the following hypotheses are proposed:

H11: *The effect of SIM on CI is mediated by SID and PU.*

H12: *The effect of SIM on CI is mediated by SID and PP.*

Based on the above analysis, the theoretical framework of this study is presented in Figure 1.

Materials and methods

Data collection

In this study, users of the sports and fitness community of Keep, a popular sports and fitness application in China, were investigated. Keep was launched on February 4, 2015. According to China Insights Consultancy, Keep had the largest online fitness user base in China, with a monthly average of 34.4 million active users in 2021. The introduction of social interaction functions in the Keep community is a powerful supplement to the core fitness experience provided by the platform. The active community brings stronger incentives, a more intense sense of competition, and closer mutual connection, which helps to enhance user loyalty. In 2021, the Keep community had a total of 1.7 billion interactions (including posts, likes, and comments). This identifies the Keep community as a sport and fitness system that provides gamification and socialization services. Therefore, it is an ideal research target for this study.

A web-based questionnaire was designed on "Wenjuanxing," which is a very popular online survey platform. The link to the questionnaire was posted in the Keep community from 17th February 2022 to 10th March 2022 and participants were invited to provide their responses to the questionnaire. The questionnaire was online for 4 weeks and a total of 417 responses were collected. Of these, 77 were excluded because of unfinished answer, and 44 were excluded because of missing values. The number of valid responses was 296, resulting in a 70.98% valid response rate, which meets the requirements of the number of samples for structural equation modeling (SEM) analysis. The results of the demographic analysis are detailed in Table 1.

Measures

A 5-point Likert scale was recommended by scholars in the scale development process because it provides an easier response process for respondents but does not pose a major disadvantage compared to the 7-point Likert scale in terms of reliability (78). The applied Likert scale ranges from strongly disagree to strongly agree, coded as 1 to 5, respectively.

Specifically, the six constructs of this study consist of 19 sub-variables. The items originate from previous research and are modified according to the research topic (as shown in Table 2). The questionnaire also collects demographic data of respondents, such as age, gender, educational background, monthly income and region.

The scales of CI and PU were adapted from Venkatesh and Davis (37), Bhattacherjee et al. (81), and Moon and Kim (53) who focused on the adoption and continual use of information technology. The scale of SIM was adapted from Venkatesh and Davis (37) as well as Moore and Benbasat (36), because both studies considered the improvement of the image resulting from the adoption of the innovation. The scale of SN was adapted from Venkatesh and Davis (37), Rhodes and Courneya (79, 80) because they addressed the relationship between SN and behavior. The scale of PP was adapted from Moon and Kim (53), who introduced pleasure as a factor (intrinsic motivation), reflecting users' intrinsic beliefs in world-wide-web acceptance. The scale of SID was adapted from Zhou and Li (14), who studied continuance use from the perspective of SI.

To critically evaluate the influence of SI on users' CI toward Keep, the following outcomes of SEM-based statistical tests help to either justify or nullify the hypotheses proposed in this paper. Firstly, prior to any statistical analysis, all negative statements were recoded. Secondly, a factor analysis was performed on all variables. For the characteristics of SN, three factors were produced out of four. For characteristics of SID, three factors were produced out of three. For the characteristics of SIM, four factors were produced out of four. For the characteristics of PU, three factors were produced out of three. For the characteristics of PP, three factors were produced out of three. For the characteristics of CI, three factors were produced out of three. Based on the statements of each factor, the factors were then labeled.

Measurement model

SEM was used for data analysis through the covariance-based SEM (CBSEM) software AMOS version 21. CBSEM clearly outperforms partial least squares in terms of parameter consistency making it preferable in terms of parameter accuracy if the sample size exceeds a certain threshold (i.e., 250 observations) (82).

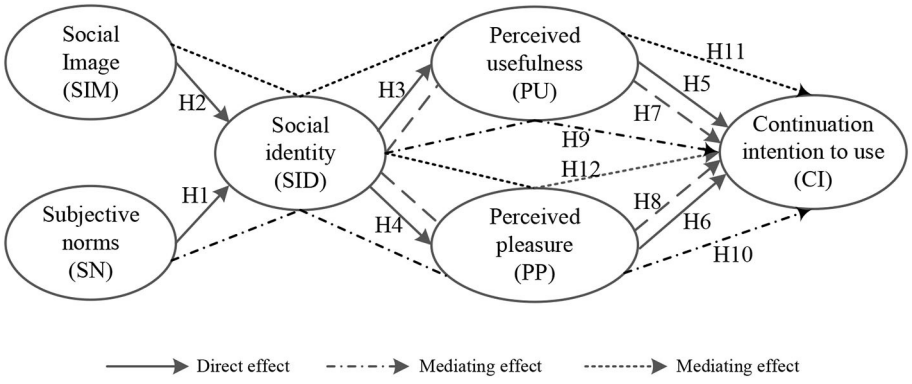

FIGURE 1
The theoretical framework.

TABLE 1 Description of the respondents ($N = 296$).

	Characteristics of respondent	Frequency (n)	Percentage (%)
Gender	Male	145	49.0
	Female	151	51.0
Age	20 years old and below	56	18.9
	21–30years old	142	48.0
	31–40 years old	70	23.6
	41–50 years old	21	7.1
	51 years old and above	7	2.4
Education background	Junior high school and below	8	2.7
	High school or secondary school	68	23.0
	College or undergraduate	148	50.0
	Master's degree or above student	72	24.3
Monthly income	800 ¥ and below	17	5.7
	801–2000 ¥	110	37.2
	2001–4000 ¥	72	24.3
	4001–6000 ¥	53	17.9
	6001–8000 ¥	33	11.1
	More than 8001 ¥	11	3.7
Region	Northeast China	5	1.7
	East China	96	32.4
	North China	20	6.8
	Central China	57	19.3
	South China	48	16.2
	Southwest China	54	18.2
	Northwest China	16	5.4

Data analysis was conducted in the following three steps: (1) data normality test. (2) reliability and construct validity test, and (3) structural model analysis. To assess whether the measure of CI toward sports and fitness applications includes six constructs, data were tested for normality and confirmatory factor analysis (CFA) was performed to examine the reliability and validity of the measurement model for the research variables (83, 84). The comparative fit index (CFI), a Tucker-Lewis index (TLI) > 0.90, and a root-mean-square error of approximation (RMSEA) ≤ 0.06 were used as criteria for evaluating goodness of-fit indices (85). Additionally, a SEM analysis was performed by building a mediation model to test the structural model. Finally, to assess

TABLE 2 Measurement instruments.

Construct	Name	Included/ Total items	Adapted from
SN	Subjective norms	3/4	Venkatesh and Davis, (37) Rhodes and Courneya, (79) Peng et al., (80)
SIM	Social image	4/4	Venkatesh and Davis, (37); Moore and Benbasat, (36)
SID	Social identity	3/3	Zhou and Li, (14)
PU	Perceived usefulness	3/3	Venkatesh and Davis, (37) Bhattacherjee et al., (81)
PP	Perceived pleasure	3/3	Moon and Kim, (53)
CI	Continuance intention	3/3	Bhattacherjee et al., (81) Moon and Kim, (53)

the mediation hypothesis, a Bootstrap procedure was performed using the 95% bias corrected confidence interval to assess the mean indirect mediation.

Results

Descriptive statistics

Table 3 shows the result of descriptive statistics for all variables. The mean value of SN was 3.33–3.49, and the mean of SID was 3.60–3.64. The mean value of SIM was 3.15–3.48, and the mean value of PU was 3.85–3.92. The mean value of PP was 3.54–3.85, and the mean value of CI was 3.72–3.97. The skewness and kurtosis for all constructs in the study show an adequate range of ±2, which agrees with the symmetry of the sample distribution (86).

Structural model

Confirmatory factor analysis of variables

Six constructs (i.e., SN, SIM, SID, PU, PP, and CI) were used as the main constructs. CFA was used to test the compatibility of the study for reliability and validity analyses. In addition, CFA helps to understand whether the measurements of constructs are consistent (83).

Three criteria were used to evaluate both the reliability and validity of CFA (87, 88). (1) The reliability of each index is evaluated *via* standardized factor loadings (factor loading > 0.5). (2) Cronbach's α and composite reliability are used to measure reliability (composite reliability > 0.6 and Cronbach's α > 0.7). (3) the average variance extracted (AVE) is used to measure convergent validity (AVE higher than 0.5). As shown in Table 4, the factor loadings of all variables range between 0.6 and 0.9, and factor loading is significant. Cronbach's α is > 0.8, composite reliability ranges between 0.7 and 0.9, and AVE ranges between 0.4 and 0.6. Although the AVE for PU is 0.466, it is still within the acceptable range. This result indicates that these empirical data reach convergent validity.

Discriminant validity analysis means that, when multiple indicators of a trait show a certain degree of convergence, the indicators of the trait should be negatively correlated with the measure of its opposing trait. In other words, discriminant validity is mainly used to test the degree to which measures of different traits are unrelated. In this study, the correlation coefficient between traits is tested by the bootstrap method, and the confidence interval is 95%. If the confidence interval of each trait does not contain 1, there is discriminant validity (89). According to the analysis result of this study (shown in Table 5), the confidence intervals of each trait do not contain the correlation coefficient 1 at a 95% confidence level. This implies that there is good discrimination among traits.

The observed value of χ^2/DF is 1.722 (which is < 3). The DF (degree of freedom) is the reference value for determining whether the value is too large, and the RMSEA value is 0.050 (< 0.08). The GFI (Goodness of Fit Index) value is 0.918 (> 0.90). The χ2/DF, RMSEA and GFI are the proportion of the sample covariance matrix explained by the model covariance matrix. The higher the value is, the better the model fit tends to be.

The TLI value is 0.948 (> 0.90), the CFI value is 0.956 (> 0.90), the NFI (Normed-Fit Index) value is 0.902 (> 0.90), TLI, CFI and NFI are the extent to which the fit of the study model has improved in comparison to the statistical base model. The higher the value is, the better the model fit tends to be. These results indicate that the proposed measurement model in this research fits the empirical data well.

Test of hypotheses

Path analysis was employed to test the hypotheses. Table 6 shows the results of hypothesis testing, including their standardized regression weight (Std), unstandardized regression weight (Ustd), standard error (S.E.), *t*-value, and *p*-value. According to the findings of this study, the path coefficients provide empirical support for the first six hypotheses tested in this study because this technique can be used to test multiple levels of a theoretical framework.

Analyses showed that SN has a positive impact on SID (Std = 0.448, S.E. = 0.091, *t*-value = 4.077 > 2, *p*-value = 0.000 < 0.01). In other words, SN plays a critical role in SID, which is consistent with previous studies, such as Thorbjørnsen et al. (44). Therefore, H1 was supported.

The test of H2 showed that the Std is 0.396, the S.E. is 0.101, the *t*-value = 3.686 > 2, and the *p*-value = 0.000 < 0.01. Therefore, H2 was supported. This finding is consistent with a

TABLE 3 Descriptive analysis.

		N	Min	Max	Mean		SD	Skewness		Kurtosis	
		Stat	Stat	Stat	Stat	Std. Error	Stat	Stat	Std. Error	Stat	Std. Error
SN	SN1	296	1	5	3.49	0.058	0.991	−0.287	0.142	−0.442	0.282
	SN2	296	1	5	3.36	0.067	1.154	−0.454	0.142	−0.634	0.282
	SN3	296	1	5	3.33	0.069	1.179	−0.299	0.142	−0.716	0.282
SID	SID1	296	1	5	3.60	0.056	0.958	−0.534	0.142	−0.048	0.282
	SID2	296	1	5	3.64	0.059	1.022	−0.600	0.142	−0.088	0.282
	SID3	296	1	5	3.61	0.054	0.921	−0.630	0.142	0.256	0.282
SIM	SIM1	296	1	5	3.30	0.068	1.162	−0.404	0.142	−0.628	0.282
	SIM2	296	1	5	3.38	0.060	1.031	−0.417	0.142	−0.437	0.282
	SIM3	296	1	5	3.15	0.071	1.225	−0.158	0.142	−0.859	0.282
	SIM4	296	1	5	3.48	0.061	1.044	−0.584	0.142	−0.115	0.282
PU	PU1	296	1	5	3.85	0.049	0.836	−0.794	0.142	0.834	0.282
	PU2	296	1	5	3.92	0.053	0.906	−0.611	0.142	0.049	0.282
	PU3	296	1	5	3.92	0.048	0.833	−1.078	0.142	1.992	0.282
PP	PP1	296	1	5	3.54	0.059	1.014	−0.533	0.142	−0.230	0.282
	PP2	296	1	5	3.56	0.060	1.027	−0.619	0.142	−0.104	0.282
	PP3	296	1	5	3.85	0.050	0.856	−0.388	0.142	−0.289	0.282
CI	CI1	296	1	5	3.72	0.055	0.953	−0.610	0.142	0.170	0.282
	CI2	296	1	5	3.78	0.054	0.928	−0.607	0.142	0.162	0.282
	CI3	296	1	5	3.97	0.051	0.881	−0.720	0.142	0.251	0.282

10.3389/fpubh.2022.1031520

TABLE 4 CFA analysis results.

		Ustd	S.E.	*t*–value	P	Std	SMC	C.R.	AVE	Cronbach's alpha
SN	SN3	1.000				0.648	0.420	0.803	0.512	0.816
	SN2	1.336	0.155	8.623	***	0.885	0.783			
	SN1	0.840	0.092	9.126	***	0.647	0.419			
SID	SIM1	1.000				0.760	0.578	0.822	0.536	0.820
	SIM2	0.904	0.073	12.322	***	0.775	0.601			
	SIM3	1.122	0.088	12.820	***	0.810	0.656			
	SIM4	0.848	0.071	11.913	***	0.718	0.516			
SIM	SID1	1.000				0.726	0.527	0.797	0.569	0.851
	SID2	1.222	0.118	10.338	***	0.831	0.691			
	SID3	0.926	0.091	10.227	***	0.699	0.489			
PU	PP1	1.000				0.788	0.621	0.813	0.466	0.810
	PP2	0.827	0.108	7.673	***	0.644	0.415			
	PP3	0.681	0.089	7.656	***	0.636	0.404			
PP	PU1	1.000				0.678	0.460	0.808	0.513	0.806
	PU2	1.007	0.125	8.049	***	0.630	0.397			
	PU3	1.132	0.143	7.921	***	0.770	0.593			
CI	CI1	1.000				0.685	0.469	0.827	0.545	0.825
	CI2	1.160	0.120	9.698	***	0.816	0.666			
	CI3	0.974	0.100	9.785	***	0.722	0.521			

*$p<0.05$; **$p<0.01$; ***$p<0.001$.

TABLE 5 Discriminant validity analysis results.

Relationship			Estimate	Bias–corrected		Percentile	
				Lower	Upper	Lower	Upper
SN	<—>	SIM	0.769	0.672	0.861	0.669	0.859
SN	<—>	SID	0.673	0.559	0.768	0.565	0.773
SN	<—>	PP	0.655	0.517	0.778	0.518	0.778
SN	<—>	PU	0.542	0.395	0.665	0.393	0.665
SN	<—>	CI	0.665	0.548	0.773	0.550	0.774
SIM	<—>	SID	0.689	0.566	0.794	0.566	0.794
SIM	<—>	PP	0.630	0.504	0.741	0.504	0.741
SIM	<—>	PU	0.453	0.312	0.595	0.304	0.588
SIM	<—>	CI	0.607	0.485	0.714	0.483	0.712
SID	<—>	PP	0.674	0.532	0.794	0.534	0.796
SID	<—>	PU	0.564	0.412	0.703	0.410	0.699
SID	<—>	CI	0.651	0.517	0.764	0.520	0.767
PP	<—>	PU	0.733	0.575	0.862	0.576	0.863
PP	<—>	CI	0.767	0.657	0.863	0.661	0.866
PU	<—>	CI	0.700	0.579	0.807	0.579	0.807

In the theoretical model, PU/PP mediates the SID–CI link, and SID and PU/PP mediate both the SN–CI link and the SIM–CI link. The statistical results based on model fit indices show that all values of CFA indicators are within their threshold of excellence.

recent study which argued that SIM had a positive impact on SID if it was used effectively (48).

According to the analysis, SID has a positive impact on the PU of Keep users, which supports H3. The results showed that the Std is 0.673, the S.E. is 0.075, the t-value = 8.298 > 2, and the p-value = 0.000 < 0.01. Previous research found similar results, indicating that SID significantly affects PU (49).

TABLE 6 Path coefficients and hypothesis tests.

Hypotheses	Relationship	Std	Ustd	S.E.	*t*–value	p	Result
H1	SN→ SID	0.448	0.370	0.091	4.077	***	Supported
H2	SIM→ SID	0.396	0.372	0.101	3.686	***	Supported
H3	SID→ PU	0.673	0.626	0.075	8.298	***	Supported
H4	SID→ PP	0.811	0.830	0.091	9.105	***	Supported
H5	PU→ CI	0.365	0.377	0.097	3.908	***	Supported
H6	PP→ CI	0.568	0.534	0.099	5.372	***	Supported

*$p<0.05$; **$p<0.01$; ***$p<0.001$.

H4 is also supported because the Std is 0.811, the S.E. is 0.091, the t-value = 9.105 > 2, and the p-value = 0.000 < 0.01. Regarding H5, the results of the study showed that the Std is 0.365, the S.E. is 0.097, the t-value = 3.908 > 2, and the p-value = 0.000 < 0.01. Therefore, H5 was supported. These findings are consistent with the results of previous studies, demonstrating that PU significantly influences users' intention to use technology [i.e., (58)].

The results showed a significant impact of PP on CI (Std = 0.568, S.E. = 0.099, t-value = 5.372 > 2, and p-value = 0.000 < 0.01). Therefore, H6 was supported, and the result echoes previous studies examining the effect of PP on CI [i.e., (39)].

The bootstrap method was used to analyze mediating effects. Compared to traditional methods, the advantage of the bootstrap method is that it can directly test the indirect effects of independent variables on the dependent variables, while not requiring the mediating effects to follow a normal distribution (90). Furthermore, the bootstrap method generates more reliable results with smaller samples (91). A sample size of 5,000 was selected, and percentile and bias-corrected bootstrap was selected as confidence interval method. The mediation model is acceptable (as shown in Figure 2, CMIN/DF = 2.700, IFI = 0.899, GFI = 0.891, CFI = 0.898, NFI = 0.849, and RMSEA = 0.076).

Table 7 presents the results of mediating analysis using AMOS 21.0 (CBSEM). If the indirect effects are not statistically significant, it was concluded that no mediating effect exists (92). The mediating effect works if the indirect effect is significant and the confidence interval does not contain zero and z (point estimation/SE_{in}) ≥ 1.96 (93).

PU positively and significantly mediates the SID-CI link (z = 2.762 > 1.96, bias-corrected CI is [0.123, 0.541], percentile CI is [0.108, 0.509]). SID and PU positively and significantly mediate the SN-CI link and the SIM-CI link (z = 2.406 > 1.96, bias-corrected CI is [0.032, 0.164], percentile CI is [0.026, 0.154]; z = 2.486 > 1.96, bias-corrected CI is [0.040, 0.201], percentile CI is [0.031,0.177]). As a result, H7, H9, and H11 are all supported. This is consistent with previous studies reporting that PU mediates the relationships among social recognition and SI on CIs [i.e., (4)].

However, the mediating effect of PP on the relationship between SID and CI is not significant because z = 1.906 < 1.96; therefore, H8 is not supported. The mediating effect of SID and PP on the relationship between SN and CI is also not significant, because z = 1.793 < 1.96. Likewise, the mediating effect of SID and PP on the relationship between SIM and CI is not significant because z = 1.786 < 1.96. As a result, H10 and H12 are also not supported. The results suggest that Keep's in-app gamification services are not well developed, and using Keep produces insufficient pleasure for users, which limits the mediating role of PP.

Discussion and conclusion

In today's era of the mobile Internet, how to retain users has become the priority for mobile applications. What many mobile applications, such as Keep, have in common is their attempt to engage people to maintain their ongoing behavior through the SI of virtual communities (27). The role of SI on the users' CI has been highlighted by both scholars and practitioners. This study examined how SI (mediated by perceived value) affects CI toward the users of sports and fitness applications by disaggregating the SI into SN, SIM, and SID.

Using SEM to analyze the proposed model, this paper provides empirical evidence that the SI of virtual communities positively impacts users' CI toward sports and fitness applications during the COVID-19 pandemic. Based on the survey results, SN and SIM can help the users of sports and fitness applications to improve their SID to the community, and then recognize, participate in, and perform their activities. Specifically, SID and PU serve as mediating factors in the relationships either between SN and CI or between SIM and CI. Furthermore, PU serves as the mediating factor in the relationship between SID and CI, but PP neither mediates the SN-CI link, the SIM-CI link, nor the SID-CI link. This result suggests that SI affects users' CI only by affecting their PU. The most important connection point in the SI process (i.e., SID) will increase users' perception of the usefulness of the functions of sports and fitness applications, and this perception will greatly and positively affect the users' continued intention to use the application.

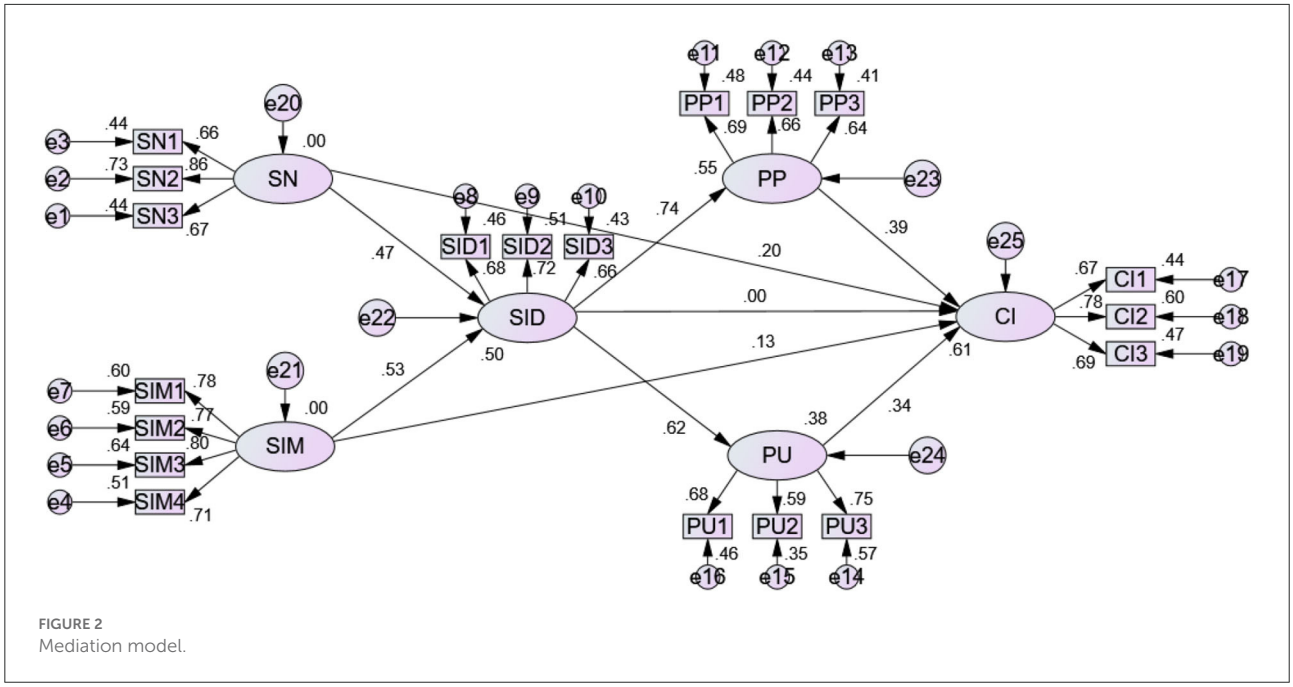

FIGURE 2
Mediation model.

TABLE 7 Mediating effect test results.

Estimated	Point estimation	Product of coef.		Bias–corrected		Percentile		Result
		SE	Z	Lower	Upper	Lower	Upper	
H7:SID–PU–CI	0.279	0.101	2.762	0.123	0.541	0.108	0.509	Supported
H8:SID–PP–CI	0.284	0.149	1.906	0.074	0.641	0.072	0.638	Not supported
H9:SN–SID–PU–CI	0.077	0.032	2.406	0.032	0.164	0.026	0.154	Supported
H10:SN–SID–PP–CI	0.104	0.058	1.793	0.029	0.253	0.026	0.244	Not supported
H11:SIM–SID–PU–CI	0.092	0.037	2.486	0.040	0.201	0.031	0.177	Supported
H12:SIM–SID–PP–CI	0.125	0.070	1.786	0.032	0.308	0.030	0.298	Not supported

Theoretical implications

This study has the potential to contribute to the field of CI research in the following three aspects:

First, when examining its role, previously, SI was mostly considered as a whole under the term "social influence" or "social norm" (4, 17). Few studies have attempted to disaggregate it and further explore its role through different conceptualizations. The present study disaggregated SI into SN, SIM, and SID and examined the impact of different conceptualizations on users' CI. Different from previous studies, this study sheds light on the conceptualizations and influencing mechanism of SI.

Second, the mediating effect of either SID or PU on users' CI has been highlighted previously (4, 69, 70). However, their chain mediating effect has been under-explored. In this study, both SID and PU were integrated to explore their chain mediating effect on users' CI. Therefore, the underlying process of the relationship between SI and users' CI was clarified.

Third, previous studies showed that it is not easy for users to maintain healthy behaviors over time (94). In addition to socialization, gamification has been regarded as an efficient way to motivate healthy behaviors is users. However, few scholars have examined the mediating role of PP in shaping users' CI. In this study, not only the mediating effect of PP on users' CI was explored, but also the chain mediating effect of both SID and PP on users' CI.

Practical implications

Sports and fitness professionals can benefit from the current study in the real-world in significant ways. First, sports

and fitness operators should be dedicated to satisfying users' expectations for real-time interactive communication. This can be achieved by creating virtual communities and working with social media, as doing so will encourage users to exchange messages with others. Real-time interactive communication makes communication with other users or online sports and fitness providers easy. Consequently, users can get the information they need during the interaction or become friends with users with shared interests. In addition, sports and fitness suppliers should provide users with information on how to improve the efficiency of sports and fitness, useful sports and fitness equipment, and sports and fitness health knowledge in the sports and fitness community in a timely manner. Such information enables users to gain knowledge effectively and make quick decisions. Through long-term content marketing that reflects interests, current events, or hot topics, interest and active participation in discussions and interactions can be generated in users. This enhances users' sense of belonging to the sports and fitness community and their intention and behavior to continue using the application.

Second, the influence of key opinion leaders in the sports and fitness industry can have a positive publicity role. Most sports and fitness users, according to the survey, are between the ages of 21 and 30. This age group is active and passionate, and they frequently share their usage of sports and fitness platforms and services through social media and other channels. Moreover, people in this age group are more willing to accept the use of new technologies and new products, as doing so can enhance the status of the individual. Therefore, operators should cooperate with key opinion leaders who are in line with the brand's image. Users are less inclined to abandon a platform or group if the group contains many people they are familiar with. However, when an issue arises within the platform or community that the user cannot overlook or accept, users not only leave but also encourage those around them to do the same. Therefore, when sports and fitness platforms develop according to the network model, it is necessary to pay attention to relationship management, while improving the service quality of the platform and the ability to deal with unexpected problems. Doing so can avoid the occurrence of "bad news travels fast, while good news take the scenic route."

Finally, although the SI of virtual communities will enable users to discover the value of the platform, sports and fitness operators should consider whether their platform is more useful than other existing sports and fitness platforms. Improving the quality of sports and fitness courses, knowledge, equipment, data monitoring, paying attention to the setting of gamification mechanisms in the system, and providing users with high-quality, personalized, and gamified sports and fitness services can help the sports and fitness platform to operate continuously and be loved by its users. This will arouse the intention of users to recommend the platform to those around them. Perceived pleasure is supposed to influence users' continuance intention. However, the non-significant mediating role of perceived pleasure showed by this study suggests that at this stage, social influence does not have a significant impact on the continuance intention of Keep users through perceived pleasure. This urges Keep to increase the number or improve the quality of in-app gamification services to stimulate users' pleasure in order to increase their continuance intention.

Limitations and future research

In the following, research limitations are summarized to favorably contribute to future studies. First, this study was based on a sample of Keep users in China. However, as culture or preferences of each country and region differ, whether the results of this study can be generalized to others countries is an interesting question for future work.

Second, this study presents a cross-sectional measurement of sample collection at a certain point in time. Therefore, the developed theoretical model cannot explain the factors of users' CI over a specific period or the changes in user intention over time. The authors recommend that scholars make time series observations of homogeneous samples to assess the transition from initial use to sustainable use in depth.

Third, this study explores individual and community-related impacts from a community-impact perspective, but it does not discuss other environments outside the community or the relationship between sports and fitness operators and users. Future research can explore the impact between sports and fitness operators, as well as platforms and users.

Finally, this study mainly explored the characteristics and environment of users and sports and fitness apps in the sports and fitness community without having a particularly deep understanding of the influencing mechanisms of each part. For example, in terms of platform, the impact of the interface design, process, and stability of the sports and fitness application on the CI of sports and fitness users can be further explored. This can achieve a deeper and more thorough understanding of the impact of the continuous use of sports and fitness applications.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

Conceptualization and software were contributed by ZL. Data curation and formal analysis were contributed by ND and BW. Writing—original draft was contributed by ND and ZL. Revised manuscript: ZL, ND, and CO-D.

All authors contributed to the paper and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Appendix A: Research items.

SN	People who are important to me think that I should use Keep.
	People who influence my behavior think that I should use Keep.
	People I look up to expect me to use Keep.
SID	I have a strong feeling of belonging toward Keep.
	I am an important member of Keep.
	My self–image overlaps with the identity of Keep.
SIM	People in my exercise group who use Keep have more prestige than those who do not.
	People in my exercise group who use Keep have a high profile.
	Having Keep is a status symbol in my exercise group.
	Using Keep improves my image within the exercise group.
PU	Using Keep enhances my effectiveness in my exercise.
	Using Keep in my exercise increases my productivity.
	I find Keep to be useful in my exercise.
PP	When interacting with Keep, I do not realize the time elapsed.
	When interacting with Keep, I am not aware of any noise
	Using Keep keeps me happy for my exercise.
CI	I intend to continue using the Keep on my exercise.
	I will frequently use Keep in the future.
	I will strongly recommend others to use Keep.

frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 16 November 2022
DOI 10.3389/fpubh.2022.1035174

OPEN ACCESS

EDITED BY
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SPECIALTY SECTION
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

RECEIVED 02 September 2022
ACCEPTED 26 October 2022
PUBLISHED 16 November 2022

CITATION
Park J, Park Y, Yoo JL, Yue G and Yu J (2022) Can the perceived risk of particulate matter change people's desires and behavior intentions? *Front. Public Health* 10:1035174. doi: 10.3389/fpubh.2022.1035174

Can the perceived risk of particulate matter change people's desires and behavior intentions?

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Particulate matter (PM) is a hazardous airborne pollutant that encompasses all airborne particles with diameters ranging from 0.001 to 100 μm. It is composed of total suspended particles (TSPs), consisting of two main particle sizes: PM10 and PM2.5. PM poses various threats to human health because of its rapid mobility and its ability to spread over a wide area. In particular, it has long-term negative effects on such organs as the lungs and heart. China and South Korea, located in Northeast Asia, are representative of the countries at risk of PM, and their populations live with an awareness that the harms of PM go beyond physical risks. Therefore, based on previous studies, this study classifies the perceived PM risks into physical, psychological, financial, functional, and time risks. It has tried to verify the effect of this risk perception on the behavior intention of Chinese and Koreans and examine the moderating effect according to the difference in nationality. The study's conceptual model was constructed by applying Ajzen's proven theory of planned action. Utilizing AMOS 22.0 and SPSS 22.0, an analysis was performed. Following this analysis, it was determined that there was a significant causal relationship between perceived PM risk and behavioral attitudes, subjective norms, and perceived behavioral control. Additionally, it was discovered that perceived PM risk significantly impacted desire and behavioral intention. These findings demonstrate that when persons are exposed to high concentrations of PM, they perceive a variety of risks that go beyond the merely physical, and they can form different attitudes depending on their nationality. This study greatly contributes to the theoretical and practical implications by presenting more diverse perspectives on PM risk.

KEYWORDS

particulate matter, perceived risks, TPB, desire, behavior intention

Introduction

Rapid economic growth and industrialization have created a new social problem and threat to human health in the form of particulate matter (PM). PM is a dangerous airborne pollutant that encompasses all airborne particles whose diameters range from 0.001 to 100 μm (1). PM is composed of total suspended particles (TSPs), consisting of two main particle sizes: PM10 and PM2.5. PM10, and PM2.5 are very different from the traditional dust that can be generally observed around us, and they can be categorized into fine dust and ultra-fine dust according to their diameters. PM10, which we call "fine dust," is dust smaller than 10/1,000 mm, and PM2.5, which we call "ultra-fine dust," is dust smaller than 2.5/1,000 mm, less than 1/20th to 1/30th the diameter of a human hair (about 60 μm). Only an electron microscope can detect it (1, 2). This fine PM may be much more common than we think. Its primary sources are vehicles, power plants, and such activities as burning coal and wood for fuel. Natural disasters, such as natural or man-made wildfires, can also release PM into the atmosphere (3). According to one misconception, fine PM only affects the quality of outdoor air, but it is also prevalent in homes. PM can be added to our home through routine activities like cooking (particularly frying, stir-frying, broiling fish, etc.), smoking, or using a wood stove or other household fuel (3). These fine PM particles can also easily travel long distances, which can negatively affect the surrounding area for miles. In particular, they adversely affect human activity and the body (4, 5).

Fine PM is only one-fifth the size of a human hair. Therefore, it is highly likely to seep into the body without being filtered out of the nose or bronchi. The fine PM that enters the body and penetrates the lungs causes asthma and lung diseases, as well as inflammation due to the action of immune cells to remove it (2, 4, 5). Ultra-fine PM has a larger surface area than fine PM; more harmful substances can be adsorbed and are more likely to penetrate blood vessels and move to other human organs (3). The WHO estimates that in 2016, ∼58% of premature deaths from outdoor air pollution were related to stroke or ischemic heart disease, while 6% of deaths were attributable to lung cancer, and 18% were brought on by chronic obstructive pulmonary disease brought on by acute lower respiratory infections (4). Public awareness of the risk of respiratory and lung diseases caused by fine PM has also limited human activities (6–8). Warning messages from the government and media, such as about refraining from outdoor activities and recommending masks due to high fine PM concentrations, have raised awareness of negative risks and anxiety about outdoor activities and become an important negative catalyst for reducing outdoor activities and walking time (7–9).

Particulate matter is a global problem, affecting various regions in various ways. For decades, Northeast Asian countries have suffered from severe PM concentrations (7, 9–11). In particular, high PM concentrations in China and Korea are causing great concern, and public interest in their health problems and poor quality of life and the related risks is gradually increasing (8, 10, 11). China has experienced rapid dynamics and demographic changes because of the speed of its economic development over the past few decades. This has coincided with an increase in PM levels due to increased energy emissions and industrial waste. In particular, PM 2.5, a major health burden, plays an increasingly negative role in China's social and economic development (12). Fine PM concentrations in China have exceeded WHO air quality standards and epidemiological data demonstrate a persistent link between rising respiratory and cardiovascular disease rates and PM concentrations (8, 13). Korea is not much different from China. In instance, Korea placed first among OECD nations for PM2.5 concentration (24.8 g/m^3/year) in 2019, and 61 Korean cities were listed among the top 100 cities with high levels of urban pollution, making up the largest share among OECD members (14). The Korean government is responding to the PM problem by strengthening environmental standards and enacting the "Special Act on the Reduction and Management of Fine Dust" law in 2016 (7, 15). However, the perceived risk (i.e., physical, psychological, financial, functional, and time) of PM that has accumulated in a relatively short period is affecting people's lives in various ways (6).

In addition to the negative effects on health, high PM concentrations reduce urban residents' outings and interactions, decreasing consumption and reducing overall vitality (16, 17). Specifically, when PM accumulates, people reduce such outdoor leisure activities as jogging, walking, cycling, and hiking, and workers' productivity declines, which has a negative economic impact (16, 18, 19). Health costs rise due to various diseases associated with PM (16). Braithwaite et al. (20) and Kim et al. (21) found that high fine dust levels negatively affect psychological and mental health, increasing suicide rates and lowering the overall quality of life. Therefore, PM poses various threats to human life. Nevertheless, studies have only focused on the health effects of PM, so a broader perspective is necessary. Insight is also needed into how awareness of this risk of PM can change people's cognitive behavior. Therefore, this study investigates how this awareness can change human desires and behavioral intentions based on Ajzen's (22) theory of planned behavior (TPB), which has been proven on reasoned human actions.

The following queries are specifically addressed in this study: (1) among the perceived PM risks presented in this study, which risk is the most widely recognized; (2) does PM risk perception affect sub-factors of TPB and behavior intention through Ajzen's verified theory of TPB; (3) does the perception and behavior of PM risk differ according to nationality (China and Korea)?

Literature review

Characteristics and perceived risks of PM

One of the major global environmental issues is air pollution. Worldwide, an average of over 7 million people die prematurely each year from breathing air containing a high concentration of pollutants (23). The main substances polluting the air are persistent organic pollutants, fine dust, heavy metals, nitrogen oxides, and carbon monoxide (24). Especially harmful to humans is PM, which can have serious effects (4, 5, 25). PM can be classified according to particle size and is generally categorized into PM10 and PM2.5. The potential for health issues to be caused by the particles is directly correlated with their size. Exposure to these particles can affect both the lungs and the heart. According to WHO surveys, an increase of 10 $\mu g/m^3$ in PM10 levels is generally correlated with a 0.2–0.6% increase in daily mortality, and long-term exposure to PM2.5 increases the risk of cardiopulmonary death per 10 $\mu g/m^3$ of PM by 6–13% (23). Consequently, people are concerned about the health damage caused by PM, so they change their activity patterns, such as by refraining from outdoor activities (16–18). PM also leads to psychological fear and physical risk for workers (16, 19), which lowers their productivity and entails financial risk, psychological risk, and negative consequences such as drugs or suicide (21, 26). Therefore, people can experience various risks through PM, and the anxiety consumers feel about the uncertain results that may arise can be defined as perceived risk (27, 28).

Perceived risk refers to the psychology behind people's behavior as it reflects uncertainty toward the future. These uncertainties directly affect people's behavioral responses (29–31). The term "perceived risk" also refers to how someone feels and comprehends the many externally present threats, emphasizing the impact of personal experiences on hunches and subjective impressions (31). This risk awareness is fundamental in psychological and physical risk environments, as it determines which risks people are concerned with and how they respond to them (31, 32). Perceived risk can be categorized according to several dimensions, measured through various indicators (28). Stone and Grønhaug (33) found that perceived risk includes physical, psychological, financial, social, functional, and time risks. In examining green consumer electronic products, Pathak and Pathak (34) classified the perceived risk into five sub-dimensions, physical, psychological, financial, functional, and time, and verified the significance of each. In examining the perceived risk and psychological distance of air pollution, Liu et al. (30) showed that people could perceive physical, psychological, economic, and functional risks according to air pollution. Therefore, this study presents physical, psychological, financial, functional, and time risks as sub-factors of the perceived risk of PM and attempts to verify the effect.

Physical risk

In the environmental sector, physical risks are often characterized as dangers brought on by the physical consequences of environmental deterioration and climate change (35). Environmental destruction poses various threats, but the most critical issue these days is the risk caused by PM. PM shortens the lifespan of the entire body, beginning with the fetus and continuing until death, which causes premature mortality, primarily due to respiratory and cardiovascular problems (2, 4, 12). The everyday consequences of PM are becoming increasingly serious and severely threatening our health (2–4). Exposure to PM can lead to premature death from cardiovascular disease (arrhythmia, heart attack) and respiratory diseases (asthma attack, bronchitis, pneumonia) (2, 4). In addition to the negative effects on health, PM accumulates, increases such as hospital visits, hospitalizations, absences from school and work, and limited outdoor activities. Yan et al. (16) and Sass et al. (26) found that in areas with high levels of PM, the perceived risk to the body tends to lead people to reduce the amount of time they spend outdoors. Their research has also shown that high levels of PM harm the pathogenesis of the brain and psychiatric disorders (3, 26) and entail an exceptionally high risk for the elderly and children. However, PM has also been proven to affect healthy people (3).

Psychological risk

Psychological risk is the possibility of a psychological injury occurring when a person is exposed to a hazard. From a psychological standpoint, hazards are instances or elements that might raise the possibility of a stress response, essentially a bodily, psychological, or emotional reaction (36). A higher risk of chronic disease and mortality is linked to psychological discomfort, which can also affect everyday living activities and social interaction. People tend to spend less time outdoors in areas with high PM levels. This avoidance behavior reduces the number of times people are exposed to sunlight, which increases the likelihood that vitamin D deficiency will cause or exacerbate psychological risk (26, 37). In addition, high PM concentration levels negatively affect psychologically such as increased anxiety, psychosis, perceived stress, depression, and suicide rates (20, 21). In this context, Sass et al. (26) found that increased psychological anguish is significantly linked to PM2.5. Additionally, Clifford et al. (38) and Luo et al. (39) also found a significant relationship between PM and anxiety, suicide, and depression.

Financial risk

Financial risk is the potential for monetary loss on an investment or business venture (40, 41). Climate change poses major risks that are already affecting the lives and finances of many people. PM has a complex relationship with climate change. PM can have either warming or cooling effects on the

climate (42). Global insurance firm Marsh McLennan estimates that climate change will put about 2% of global financial assets at risk by 2100 (43). Therefore, PM, which plays an essential role in climate change, may entail various financial risks. A high level of PM reduces people's consumption activities. It affects sales of nearby stores, which in turn has a dangerous effect on the finances of the companies that produce the products sold. Additionally, it causes a rise in prices due to decreased production of agricultural and fishery products and generates additional expenditures due to the installation of air purifiers at home, further purchases of masks, and increased use of delivery food. Guo et al. (44) found a positive correlation between the air quality index (AQI) of some Chinese cities and the stock price return of local companies.

Functional risk

Perceived risks may include functional risks, which may raise fears and suspicions that external hazards will prevent people from conducting a plan or activity. People are restricted from outdoor activities due to particulate matter, and implementing policies such as government measures to reduce PM also limits the use of vehicles. Regarding physical functional risk, long-term exposure to airborne particulates leads to cognitive decline. A Chinese study found that exposure to PM reduced cognitive abilities in speech and math tests (45). Additionally, high levels of PM impair cognitive function in decision-making and reduce productivity and worker performance (39). Kahn and Li (46) also found that prolonged exposure to PM increased the risk of death and lowered the emotional wellbeing and productivity of outdoor workers.

Time risk

Perceived risks from PM may also include time risks (6, 30, 33). Time risk refers to wasted or lost time as a result of bad decisions or unexpected circumstances. Purchasing an item is a representative example of time risk. Time risk involved includes navigation and/or submitting orders to buy, waiting for delivery of the item to home, and returning it for a replacement because the product does not meet consumer expectations (47–49). If we apply this to the PM risk, the time required to purchase and install an air purifier due to deteriorating air quality and the time it takes for regular maintenance can be perceived as time risks. Other examples of time risks are reducing leisure and economic activity (work) hours, changing business schedules due to high PM concentration, using public transportation to lower pollution levels, and purchasing masks to prevent health problems (49, 50). Therefore, this perception of time risk has been found to have a negative effect on people's behavior and intentions (48).

Theory of planned behavior

The TPB is a psychological theory that links beliefs to behavior. Ajzen (22) developed TPB to increase the predictive capacity of the theory of reasoned action (TRA). TPB was intended to incorporate perceived behavioral control. TPB views individuals as rational decision-makers who weigh all possible outcomes before making a choice (22). The theory contends that three fundamental variables—attitude, subjective norms, and perceived behavioral control—significantly impact a person's behavioral intentions (22). Attitude, one of the constituent factors of TPB, indicates how an individual evaluates a given behavior, whether positively or negatively, and predicts the intention to perform a protective behavior (22, 51). Subjective norms manifest social influence and are defined as the extent to which people feel pressured or not to perform (or not) an action by significant others (51). Perceived behavioral control can be described as "an individual's beliefs about how easy or difficult the performance of a behavior is." (22). The most proximal predictor of human social behavior, in turn, is the behavioral intention, which is a core principle of TPB (22). Behavioral intentions represent upcoming behaviors people expect and prepare for (52). They show expectations associated with particular behavior in a specific mechanism and can be considered to predict the likelihood that the behavior will be performed (22, 51, 52). Therefore, the TPB has been used in several academic disciplines to understand better the processes by which conscious decisions are made, particularly concerning environmental and health risks (53).

Perceived risks are fundamental to environmental and health risk communication, as they determine which risks people are concerned with and how they respond (27). An individual's social, cultural, and situational factors influence that individual's perceptions and are significantly causally related to attitudes, behaviors, and perceived behavior control (27, 54). Fishbein and Yzer (55) suggested that risk perception can be conceptualized as a terminal predictor of behavioral intention. Risk perception can be regarded as an essential determinant of behavioral intention through subjective norms (56). When individuals engage in a certain behavior, risk perception interacts with perceived behavioral control, and an individual's risk perception increases their desire to act according to their sense of self-efficacy to engage in preventive behavior (57). People with higher risk perception are more responsive to behavioral consequences (attitudes) to form positive intentions. According to an air pollution study, persons who experience adverse health effects from PM evaluate the risk as more severe, have higher environmental standards and are more inclined to act to lessen the risk (57, 58). In particular, direct experience with risk minimizes an individual's psychological distance from risk and encourages risk mitigation measures (59). Psychological distance is an individual's perception that affects behavior, and the farther

the psychological distance to the environment, the less eco-friendly intention, and the closer the psychological distance to the environment, the more positive to support and participation in pro-environmental behavior (30). Thus, when people perceive the various dangers of PM, they can increase their desire and intention to perform specific behaviors while reducing their psychological distance. In particular, an individual's normative behavior toward the perceived risk of PM significantly affects the intention to take preventive actions under the influence of surrounding groups and social factors (60–62). In light of previous research, the following hypotheses are put forth:

Hypothesis 1: The perceived risk of PM negatively affects attitude toward the behavior.

Hypothesis 2: The perceived risk of PM negatively affects the subjective norm.

Hypothesis 3: The perceived risk of PM negatively affects perceived behavioral control.

Hypothesis 4: The attitude toward the behavior positively affects desire.

Hypothesis 5: The subjective norm positively affects desire.

Hypothesis 6: The perceived behavioral control positively affects desire.

Hypothesis 7: The desire positively affects behavior intention.

PM perception in China and Korea

Like many other nations that experienced rapid industrialization, China and Korea experienced strong economic growth and severe pollution before concerted attempts were made to improve air quality (9–11). China, in particular, has seen significant increases in energy consumption and air pollution emissions due to rapid economic growth. As a result, fine PM pollution is one of the most critical environmental problems in modern-day China, especially in highly industrialized urban areas (10, 11, 59). Given the many threats that PM demonstrably poses to human health, the Chinese public has perceived the risks posed by air pollution as being more severe (11, 63, 64). This is because regular haze pollution has increased public anxiety in China and raised the possibility of civil instability (64). Lee (65) established that Chinese adolescents' risk perception toward environmental messages (e.g., PM severity) positively affected environmental attitudes and shaped their environmental desire and behavior intentions. Yan and Wu (53) also found that public perception of PM risks significantly affected their attitudes, norms, and behavioral intentions.

According to the Korean National Institute of Environmental Research, Seoul, Korea, is one of the world's most polluted cities. Seoul's mean PM10 levels were higher between 2009 and 2013 than in several of the world's biggest cities, including Los Angeles, Tokyo, Paris, and London (66). In addition, in 2019, its PM2.5 concentration (24.8 $\mu g/m^3$/year) was the highest among OECD nations (7). Korean interest in PM increased after the 1988 Seoul Olympics, as the government concentrated on the air pollution condition, remedial actions, and anticipated risk levels based on the season (7, 67). In particular, people had a greater perception of PM risks with increased media attention and warnings about outdoor activities and masks (67). In addition, the perceived risk of PM differed depending on the region. Kim et al. (7) and Whitmarsh (58) found a correlation between residency in areas with severe PM and negative attitudes and behavioral intentions. Furthermore, the risk perception of air pollution significantly affects self-protection through attitudes, perceived norms, and self-efficacy (68).

Public perception of PM influences its emotional and behavioral responses (69). Research has found that if the AQI rises by 100 points on a given day, "emigration" searches will increase by roughly 2.3–4.8% the next day. In addition, such an effect is more pronounced when the AQI level is above 200; the effect differs according to the destination country and metropolitan area (69). In other words, numerous variables, such as gender, family income, region, age, education level, personal experiences, and health symptoms, may impact how each individual perceives air pollution (63). In addition, the public perception of PM is determined by social networks, media, and other sociocultural factors, which are highly localized (70). Considering that individuals may have different perceptions of risk depending on the degree and level of PM, their perceptions and behavior intentions may differ depending on whether they live in China or Korea. In light of previous research, the following hypotheses are put forth:

Hypothesis 8a: Nationality moderates the relationship between the perceived risk of PM and attitude toward behavior.

Hypothesis 8b: Nationality moderates the relationship between the perceived risk of PM and subjective norm.

Hypothesis 8c: Nationality moderates the relationship between the perceived risk of PM and perceived behavioral control.

Hypothesis 8d: Nationality moderates the relationship between attitude toward behavior and desire.

Hypothesis 8e: Nationality moderates the relationship between subjective norm and desire.

Hypothesis 8f: Nationality moderates the relationship between perceived behavioral control and desire.

Hypothesis 8g: Nationality moderates the relationship between desire and behavior intention.

Research model

The 12 theoretical components that make up this study's conceptual framework explain how the perceived risk of PM affects people's behavioral intentions. In the conceptual

framework of the presented study, the moderating effect of nationality (China and Korea) is added to examine the difference. In this study, the perceived risks of PM are classified into physical, psychological, financial, functional, and time risks. The suggested theoretical framework has a total of eight hypotheses. Figure 1 displays the research model that this study presents.

Methodology

Measurement tools

In this study, the perceived PM risk (e.g., physical, psychological, financial, functional, time), Attitude through Ajzen (22)'s Theory of Planned Behavior (TPB), using measurement items whose reliability and validity have been verified in prior research. The attitude toward the behavior, subjective norm, perceived behavioral control, desire, and behavioral intention were measured. Specifically, three questions were used for each of the five risks presented to measure the perceived risk of PM based on Dayour et al. (71); Quintal et al. (72). Also, according to Han (73), Perugini and Bagozzi (74), Ajzen (22), and Han et al. (75), each of the three questions measured attitude toward the behavior, subjective norm, perceived behavioral control, and desire. Finally, according to Han and Yoon's (76) research, three questions were used to measure behavioral intention. All of the questionnaires used in this study were multi-item, and the respondents were people living in areas with high PM concentrations in China and Korea. Responses were rated on a 7-point Likert scale ranging from 1 to 7 points (strongly disagree to strongly agree, respectively). In addition, a preliminary test was conducted so that survey respondents could understand the survey content more clearly and revise and supplement the survey content. The preliminary test was conducted for university professors majoring in environmental engineering and graduate students majoring in atmospheric environmental engineering.

Data collection and sample characteristics

In this study, a sample was selected through the web-based system of a data collection institution, and the collected questionnaire was used for analysis. The respondents were randomly chosen via email from those who experienced PM in China and Korea. A total of 322 persons were recruited through this method, and 318 persons were included in the empirical analysis; four individuals were excluded for insincere answers. Using SPSS 22.0, frequency analysis was performed to determine the demographic details of the sample. Specifically, the following are the demographic details of the survey respondents: By nationality, 42.1% were Chinese, and 57.9% were Korean. By gender, 48.1% were male, and 51.9% were female; for age, 33% were under the age of 20, 46.5% were in their 30s, 17% were in their 40s, and 3.5% were over the age of 50; in terms of annual income, 13.5% had less than US$30,000, 81.8% had between US$30,000 and US$50,000, 4.1% had between US$50,000 and US$70,000, and 0.6% earned more than US$70,000; regarding academic background, 7.2% of respondents had a college degree, 82.4% had a bachelor's, and 10.4% had a master's or higher; regarding marriage, 63.8% were single, and 36.2% were married.

Results

Presented measurement model results

Confirmatory factor analysis (CFA) was performed in this study to assess the validity and reliability of the proposed research model. CFA is the most practical analysis technique for confirming the validity and one-dimensionality of the scale, as well as the reliability of the measurement model (77). The analysis results through CFA are as follows. The statistical validity of the measurement model used in this investigation was satisfactory with $\chi^2 = 944.111$, df $= 360$, $p < 0.01$, χ^2/df $= 2.623$, RMSEA $= 0.072$, CFI $= 0.935$, TLI $= 0.921$. Standardized regression weights were then measured to confirm the reliability of the measured properties. Results ranged from 0.648 to 0.925. Therefore, reliability was confirmed, exceeding the standardized regression weight of 0.5 for all assessed attributes. The average variance extracted (AVE) and composite reliability (CR) values were analyzed to verify the proposed measurement variables' internal consistency and central validity. As a result, AVE values arranged from 0.652 to 0.723, and CR values ranged from 0.849 to 0.887. As a result, it can be concluded that the measured attributes have acceptable internal consistency and central validity. Finally, discriminant validity was examined to confirm that the proposed notions could be distinguished. When the AVE value is greater than the square of the correlation coefficient, the discriminant validity can be irreproachable (78). Because the AVE value was greater than the correlation coefficient's square value, the analysis's findings supported discriminant validity. The results of CFA are presented in Table 1.

Structural equation modeling

This study verified conceptual characteristics and proposed hypotheses using the maximum likelihood method through structural equations. The model fit for this study was found to be adequate with $\chi^2 = 1141.166$, $df = 391$, $p < 0.01$, $\chi^2/df = 2.919$, RMSEA $= 0.078$, CFI $= 0.916$, TLI $= 0.907$. Therefore, as a result of testing the lower five risk factors of

10.3389/fpubh.2022.1035174

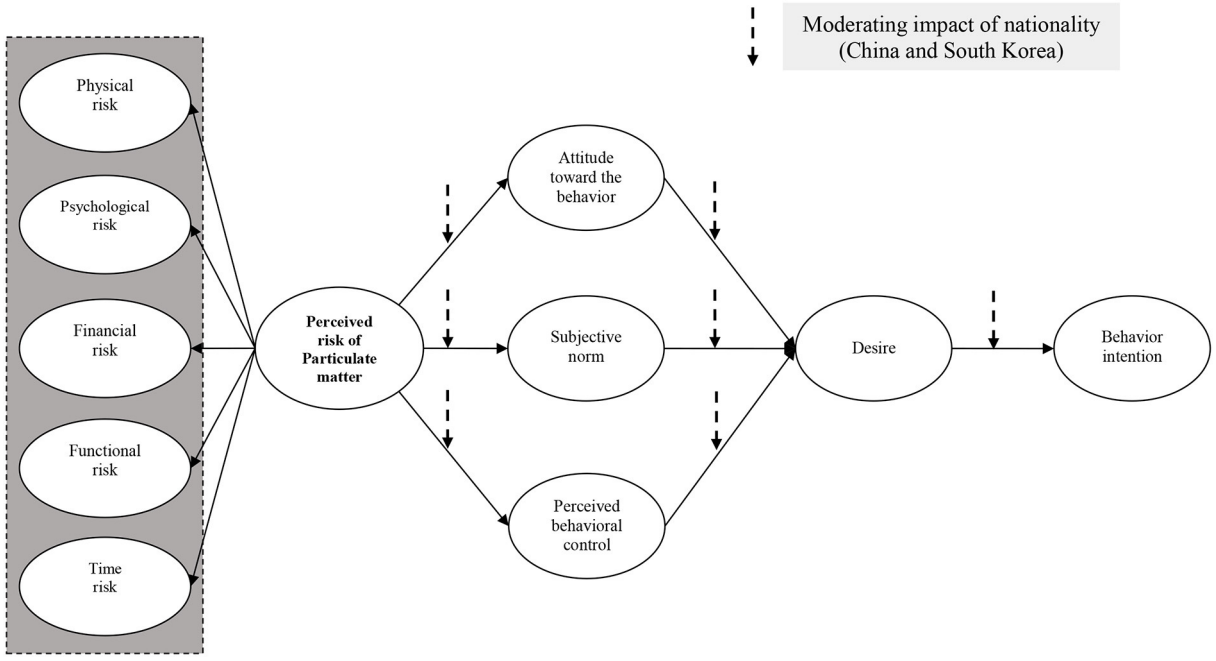

FIGURE 1
Proposed conceptual framework.

perceived risk of PM presented in this study, it was found that people perceive all five risks as significantly high. The results of the initial seven hypotheses presented are as follows. As a result of testing hypotheses 1, 2, and 3, perceived risk of PM has a negative affect on attitude toward the behavior ($\beta = 0.785$, $p < 0.01$), subjective norm ($\beta = 0.831$, $p < 0.01$) and perceived behavioral control ($\beta = 0.862$, $p < 0.01$) was also found to have a negative effect. Therefore, hypotheses 1, 2, and 3 were supported. Next, the effect of attitude toward the behavior, subjective norm, and perceived behavioral control on desire was verified. As a result, attitude toward the behavior and desire ($\beta = 0.292$, $p < 0.01$), subjective norm and desire ($\beta = 0.194$, $p < 0.05$), perceived behavioral control and desire ($\beta = 0.256$, $p < 0.01$) were all significant appeared to have an impact. Therefore, hypotheses 4, 5, and 6 were all supported. Finally, the effect of desire on behavioral intention was tested. Desire was found to have a significant effect on behavioral intention ($\beta = 0.633$, $p < 0.01$). Therefore, hypothesis 7 was supported.

The use of a mediating framework can greatly help understand the complex relationships between study components within a theoretical model (58). Therefore, indirect effects were validated using bootstrap to help understand the complex relationships in the model. Following the analysis, the perceived risk of PM was determined by desire ($\beta_{\text{Perceived risk of particulate matter} \rightarrow \text{attitude toward the behavior \& subjective norm \& perceived behavior control} \rightarrow \text{desire}} = -0.612$), behavior intention ($\beta_{\text{Perceived risk of particulate matter} \rightarrow \text{attitude toward the behavior \& subjective norm \& perceived behavior control \& desire} \rightarrow \text{behavior intention}} = -0.388$) had a significant indirect effect. The components of TPB are attitude toward the behavior and behavior intention ($\beta_{\text{Attitude toward the behavior} \rightarrow \text{desire} \rightarrow \text{behavior intention}} = 0.185$), subjective norm and behavioral intention ($\beta_{\text{Subjective norm} \rightarrow \text{desire} \rightarrow \text{behavior intention}} = 0.123$), perceived behavioral control and behavior intention ($\beta_{\text{Perceived behavior control} \rightarrow \text{desire} \rightarrow \text{behavior intention}} = 0.162$), significant indirect effects were verified only between subjective norm and behavioral intention. Therefore, the mediating role of attitude toward the behavior, subjective norm, perceived behavior control, and desire within the theoretical framework presented in this study was partially demonstrated. Table 2 shows the results of these analyzes.

Structural invariance model assessment

The proposed research model for the effect of perceived PM risk on behavioral intentions conducted an invariance test to identify the moderating roles according to nationality (China and Korea). Therefore, the proposed hypothesis H8a–g was tested by dividing it into a Chinese group ($n = 134$) and a Korean group ($n = 184$). Analysis revealed that nationality differences in the relationship between perceived risk of PM and attitude toward the behavior [$\Delta\chi 2\ (1) = 4.812$, $p < 0.05$] play a

TABLE 1 Presented measurement model results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Physical risk (1)	1.000									
Psychological risk (2)	0.651[a]	1.000								
	(0.423)[b]									
Financial risk (3)	0.621	0.522	1.000							
	(0.385)	(0.272)								
Functional risk (4)	0.592	0.532	0.671	1.000						
	(0.350)	(0.283)	(0.450)							
Time risk (5)	0.620	0.539	0.427	0.619	1.000					
	(0.384)	(0.290)	(0.393)	(0.383)						
Attitude toward the	−0.407	−0.452	−0.522	−0.534	−0.638	1.000				
behavior (6)	(0.165)	(0.204)	(0.272)	(0.285)	(0.407)					
Subjective norm (7)	−0.422	−0.472	−0.588	−0.625	−0.477	0.550	1.000			
	(0.178)	(0.222)	(0.345)	(0.390)	(0.227)	(0.302)				
Perceived behavior	−0.484	−0.487	−0.461	−0.595	−0.598	0.618	0.590	1.000		
control (8)	(0.234)	(0.237)	(0.212)	(0.354)	(0.357)	(0.381)	(0.348)			
Desire (9)	−0.335	−0.374	−0.608	−0.469	−0.616	0.585	0.591	0.589	1.000	
	(0.112)	(0.139)	(0.369)	(0.219)	(0.379)	(0.342)	(0.349)	(0.346)		
Behavior intention	−0.366	−0.464	−0.492	−0.466	−0.536	0.505	0.484	0.580	0.620	1.000
(10)	(0.133)	(0.218)	(0.242)	(0.217)	(0.287)	(0.255)	(0.234)	(0.336)	(0.384)	
Mean	5.024	4.693	5.090	5.169	4.860	2.711	2.967	2.656	2.812	4.715
SD	1.249	1.220	1.367	1.205	1.299	1.090	1.252	1.303	1.325	1.300
CR	0.855	0.880	0.853	0.857	0.849	0.887	0.856	0.880	0.860	0.886
AVE	0.662	0.710	0.660	0.667	0.652	0.723	0.664	0.710	0.672	0.721

Goodness-of-fit statistics for the measurement model: $\chi^2 = 944.111$, df = 360, $p < 0.001$, $\chi^2/df = 2.623$, RMSEA = 0.072, CFI = 0.935, NFI = 0.900, TLI = 0.921.

[a]Correlations between the variables are below the diagonal.

[b]The squared correlations between the variables are within the parentheses.

significant moderating role. However, perceived risk of PM and subjective norm [$\Delta\chi 2\ (1) = 2.784$, $p > 0.05$], perceived risk of PM and perceived behavior control [$\Delta\chi 2\ (1) = 2.729$, $p > 0.05$], attitude toward the behavior and desire [$\Delta\chi 2\ (1) = 0.158$, $p > 0.05$], subjective norm and desire [$\Delta\chi 2\ (1) = 0.009$, $p > 0.05$], perceived behavior control and desire [$\Delta\chi 2\ (1) = 0.123$, $p > 0.05$], nationality differences in the relationship between desire and behavior intention [$\Delta\chi 2\ (1) = 2.998$, $p > 0.05$] does not play a significant moderating role. Therefore, only H8a is accepted, and all H8b–H8g are rejected. Detailed results are shown in Table 3 and Figure 2.

Discussion and implications

This study helps us understand the impact of the perceived risk of PM, which threatens mankind due to rapid economic growth and industrialization, on desires and behavioral intentions through attitude, norms, and perceived behavior control. To accomplish the goal of this study, an empirical analysis was conducted. Specifically, the perceived PM risk was classified into physical, psychological, financial, functional, and time risks and the effect on three constituent variables of Ajzen's (22) verified TPB was investigated. It also examined the effect of attitude toward the behavior, subjective norms, and perceived behavioral control on desire and the effect of desire on behavioral intention. To check the difference in the perception of PM risks according to nationality, the moderating role was also verified for Chinese and Koreans, the countries most frequently exposed to the risk of PM concentration.

The results of analyzing the eight hypotheses presented in this study are as follows. First, out of the five risk factors of physical, psychological, financial, functional, and time risks presented as sub-components of the perceived risk of PM, people had a high perception of all the proposed risks. In particular, people perceive the greatest time risk when exposed to high PM levels. These results suggest that people perceive more diverse risks in addition to the health (physical) risks caused by PM, which previous studies have focused on. Therefore, this result shows the need for a more diverse approach to the perception of risk for PM and a specific approach to its potential negative impact. In addition, these results indicate the importance of

TABLE 2 Structural equation modeling.

Hypothesized paths		Coefficients	*t*-values
H1: Perceived risk of particulate matter	→ Attitude toward the behavior	−0.785	−12.540**
H2: Perceived risk of particulate matter	→ Subjective norm	−0.831	−13.724**
H3: Perceived risk of particulate matter	→ Perceived behavior control	−0.862	−14.765**
H4: Attitude toward the behavior	→ Desire	0.292	3.973**
H5: Subjective norm	→ Desire	0.194	2.489*
H6: Perceived behavior control	→ Desire	0.256	3.209**
H7: Desire	→ Behavior intention	0.633	11.186**

Indirect effect:

$\beta_{\text{Perceived risk of particulate matter} \rightarrow \text{attitude toward the behavior \& subjective norm \& perceived behavior control} \rightarrow \text{desire}} = -0.612^{**}$

$\beta_{\text{Perceived risk of particulate matter} \rightarrow \text{attitude toward the behavior \& subjective norm \& perceived behavior control \& desire} \rightarrow \text{behavior intention}} = -0.388^{**}$

$\beta_{\text{Attitude toward the behavior} \rightarrow \text{desire} \rightarrow \text{behavior intention}} = 0.185^{**}$

$\beta_{\text{Subjective norm} \rightarrow \text{desire} \rightarrow \text{behavior intention}} = 0.123$

$\beta_{\text{Perceived behavior control} \rightarrow \text{desire} \rightarrow \text{behavior intention}} = 0.162$

Explained variance:

R^2 (physical risk) = 0.723

R^2 (psychological risk) = 0.730

R^2 (financial risk) = 0.698

R^2 (functional risk) = 0.911

R^2 (time risk) = 0.741

R^2 (attitude toward the behavior) = 0.617

R^2 (subjective norm) = 0.691

R^2 (perceived behavior control) = 0.743

R^2 (desire) = 0.436

R^2 (behavior intention) = 0.401

*$p < 0.05$, **$p < 0.01$.

Goodness-of-fit statistics for the measurement model: $\chi^2 = 1141.166$, df = 391, $p < 0.001$, $\chi^2/df = 2.919$, RMSEA = 0.078, CFI = 0.916, IFI = 0.917, TLI = 0.907.

these clues to improving the understanding of the risk and behavioral responses of people living in areas with high PM concentration levels.

Next, the perceived risk of PM was found to have a significantly negative effect on attitude toward the behavior, subjective norms, and perceived behavioral control. These results are consistent with the previous studies (55–57, 59) that the perception of risks influences an individual's attitudes, norms, and behavior, thereby influencing behavior intention. That is, an individual's perception of risk toward the PM leads to a change in their attitude to the behavior. It also influences how well they can perform and control the behavior and the subjective norms of social pressures for implementing or not implementing the behavior. Therefore, this study confirms that risk perception of PM can predict individual behavior, norms, and will, and that individual behavior is formed through the interaction of such perception with the above factors. In addition, it can be seen that when individuals perceive the various risks of high-level PM, they can increase their desire and intention to perform specific actions while reducing psychological distance.

As a result of the verification of hypotheses 4, 5, and 6 presented based on the verified TPB, it was found that individual attitudes, norms, and perceived behavioral control on the impact of PM risk had a significantly positive effect on individual desires. This result supports Hamid and Bano (57), which showed that individual risk perception changes attitudes and increases the desire to actively participate in preventive actions according to self-efficacy. This study indicates that the more people are aware of the dangers of PM, the greater their desire to refrain from environmentally harmful behaviors such as the use of individual vehicles, the use of fossil fuels, and the overuse of energy. Therefore, it is necessary to recognize the various problems and risks that PM can cause and implement policies to reduce PM, such as Carbon Neutral by 2050 and ESG principles, more actively. In addition, it will be necessary to raise people's awareness of the various problems that PM can cause and prepare a plan to address them actively.

In this study, to test hypotheses H8a–H8g in the proposed concept on the individual's behavioral intention through the risk perception of PM, the moderating role of nationality (China and Korea) was examined. A significant difference can be seen. Specifically, hypotheses H8b–H8g based on the present structural model did not reveal any appreciable differences in moderating effects according to nationality. However, nationality was found to play a statistically significant moderating role in the relationship between the perceived risk of PM and attitude toward the behavior. These results show that there is no significant difference between Chinese and Korean citizens in norms, behavioral control, desires, and behavioral intentions around PM risk perception, but that there may be differences in attitude. In fact, according to IQAir's 2021 World Air Quality Report (79), the average annual PM2.5 concentration ($\mu g/m^3$) was found to be 32.6 for

TABLE 3 Structural invariance model assessment.

Paths	Korean (n = 184)	Chinese (n=134)	Baseline model (freely estimated)	Nested model (constrained to be equal)
	β	β		
H8a: Perceived risk of particulate matter → attitude toward the behavior	−0.847**	−0.706**	χ^2 (806) = 1699.560	χ^2 (807) = 1704.372[a]
H8b: Perceived risk of particulate matter → subjective norm	−0.896**	−0.750**	χ^2 (806) = 1699.560	χ^2 (807) = 1702.344[b]
H8c: Perceived risk of particulate matter → perceived behavior control	−0.911**	−0.795**	χ^2 (806) = 1699.560	χ^2 (807) = 1702.289[c]
H8d: Attitude toward the behavior → desire	0.278**	0.284**	χ^2 (806) = 1699.560	χ^2 (807) = 1699.718[d]
H8e: Subjective norm → desire	0.203	0.199	χ^2 (806) = 1699.560	χ^2 (807) = 1699.569[e]
H8f: Perceived behavior control → desire	0.304*	0.192	χ^2 (806) = 1699.560	χ^2 (807) = 1699.683[f]
H8g: Desire → behavior intention	0.698**	0.537**	χ^2 (806) = 1699.560	χ^2 (807) = 1702.558[g]

Chi-square test:

[a] $\Delta\chi^2$ (1) = 4.812, $p < 0.05$

[b] $\Delta\chi^2$ (1) = 2.784, $p > 0.05$

[c] $\Delta\chi^2$ (1) = 2.729, $p > 0.05$

[d] $\Delta\chi^2$ (1) = 0.158, $p > 0.05$

[e] $\Delta\chi^2$ (1) = 0.009, $p > 0.05$

[f] $\Delta\chi^2$ (1) = 0.123, $p > 0.05$

[g] $\Delta\chi^2$ (1) = 2.998, $p > 0.05$

Hypotheses testing:

H8a: Supported

H8b: Not supported

H8c: Not supported

H8d: Not supported

H8e: Not supported

H8f: Not supported

H8g: Not supported

Goodness-of-fit statistics for the baseline model:

$\chi^2 = 1699.560$, $df = 806$, $p < 0.001$, $\chi^2/df = 2.109$, RMSEA = 0.059, CFI = 0.902, IFI = 0.903, TLI = 0.894

*$p < 0.05$, **$p < 0.01$.

Mainland China and 19.1 for Korea. However, according to the results of this study, Korean (−0.847) and Chinese (−0.706) attitude formation varied according to PM risk perception. This result indicates that Koreans react more sensitively when it comes to attitude formation, even though China has a higher level of PM2.5 concentration. In addition, although no statistically significant difference was found in the verification of the moderating effect according to the suggested nationality, Koreans responded more sensitively than Chinese in most of the relationships ranging from risk perception and behavioral intentions with respect to PM. These results are theoretically very meaningful, as the attitudes can appear to differ depending on nationality regardless of the actual PM concentration.

The following theoretical and practical implications can be derived from the results of this study. The impact of PM on humans has already become a global concern, and thanks to government agencies and various media, people are aware of the risks of PM. However, both people's perceptions and existing studies of PM focus on risks to the human body and human activity (2–6, 8). As the results of this study indicate, people perceive a greater variety of risks due to PM, and even to that extent, the perception of time risk is higher than that of physical risk. Therefore, this study is significant because it expanded the scope of the existing perceived risk of PM, suggested more diverse risk factors, and established significance in PM research. In addition, it has verified its importance by applying the previously verified TPB of Ajzen (22) to the perceived risk of PM. Through this result, the research present very significant academic implications that the perceived risk of PM can change norms and beliefs about individual behavior and negatively affect control beliefs about the consequences of certain behaviors. Especially the environmental consequences. In addition, through the verification of the indirect effect, the three sub-factors of TPB mediate the perceived risk of PM, negatively affecting desire and behavior intention. This result provides additional academic implications for the mediating role of TPB.

The practical implications of this study are as follows. When people are exposed to the risk of PM, they become aware of its severity and respond accordingly. Specifically, when the concentration of PM is high, people refrain from

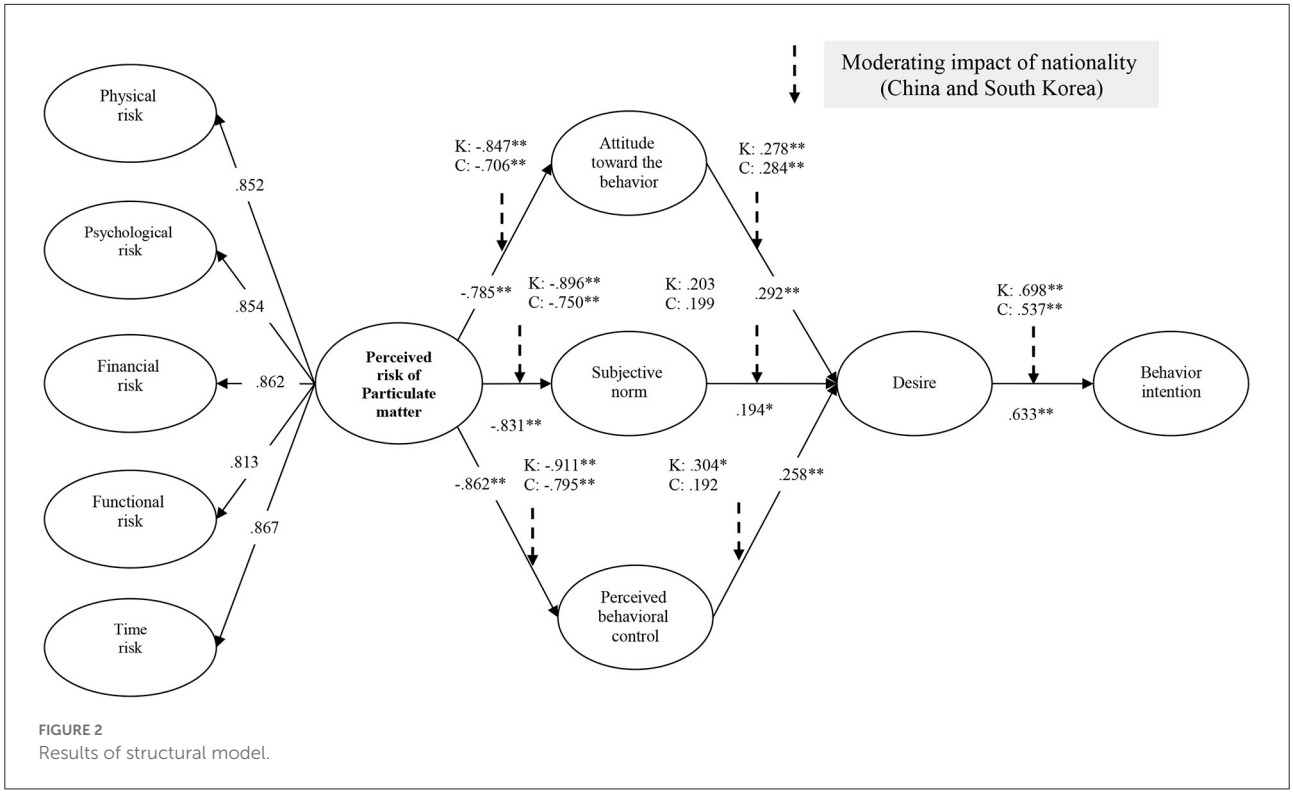

FIGURE 2
Results of structural model.

activities or behaviors that can worsen air quality through individual norms and perceived behavior control and seek ways to improve it. However, the fundamental principle is to minimize exposure to the risks caused by PM. Therefore, the government should devise a way to reduce the use of solid fuel, the main source of PM, through an international agreement to reduce PM, and companies should also make a gradual effort to switch from using solid fuel to alternative energy. If these efforts are combined with periodic education and environmental improvement campaigns for the citizens of those countries where PM occurs, the frequency of exposure to PM risks will be minimized, and the quality of life will be improved. In other words, premature death and health loss due to disease can be reduced by reducing the risk of disease occurring due to PM. Protecting health, improving quality of life, and living longer and healthier can also reduce the various risks (e.g., physical, psychological, financial, functional, and time) to society.

Conclusion

Globally, the risk of PM is an issue that cannot be overlooked. In particular, Northeast Asian countries are exposed to the risk of PM from yellow dust or solid fuel use. Therefore, to confirm the risk perceived by people due to PM, this study presented the physical, psychological, functional, financial, and time risks of PM through a literature review; examined the components of the verified TPB (e.g., attitudes toward behavior, subjective norms, perceived behavioral control); and confirmed their effect on individual desires and behavioral intentions. This study's results confirmed that people perceive risk for PM in various forms and that risk perception toward PM has a negative effect on attitude toward the behavior, subjective norm, and perceived behavioral control. In addition, the indirect effect verified that the above perception of risk has a negative effect on individual desires and behavioral intentions. Moreover, verified that there might be significant differences according to nationality in forming attitudes toward PM. Especially this study found that the perception of PM risk may differ depending on nationality or culture, rather than on actual statistical figures. Therefore, the purpose of this study was successfully achieved, and the results provided a theoretical and practical implication for the impact of PM risk perception on desire and behavior intentions have been presented.

Limitation

This study has some limitations despite the significant findings. First, the results of this study on the perception of PM risk and behavior intentions have limited generalizability because the study targeted only citizens of two Northeast Asian countries with severe PM concentrations. Second, although the perceived level of risk may differ depending on the frequency

of exposure to PM, one problem is raised that did not reflect this aspect of the study. Therefore, it is suggested that future research consider the role of nationality, cultural characteristics, the concentration level of PM, and frequency of PM throughout the year, in forming behavior intentions according to the risk perception of PM.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to conceptualization, formal analysis, investigation, methodology, and writing and editing the original draft.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 07 December 2022
DOI 10.3389/fpubh.2022.1085256

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to
Public Mental Health,
a section of the journal
Frontiers in Public Health

RECEIVED 31 October 2022
ACCEPTED 21 November 2022
PUBLISHED 07 December 2022

CITATION
Chen Y, Wei M and Ortiz J (2022) How do digital lives affect resident mental health in the digital era? Empirical evidence based on Chinese general social survey.
Front. Public Health 10:1085256.
doi: 10.3389/fpubh.2022.1085256

How do digital lives affect resident mental health in the digital era? Empirical evidence based on Chinese general social survey

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Having good mental health means we are better able to connect, function, cope and thrive. The widespread application of digital technology in daily life provides new ways and promising tools for residents to maintain their mental health. Given the importance of mental health for everyone, and the fact that mental health problems are prevalent worldwide, this study discusses how digital lives affects the mental health of residents. The results suggest that digital lives are significantly and positively associated with mental health. Mechanisms analysis identifies personal perceptions (self-rated physical exercise and subjective wellbeing) as the important paths for digital lives to promote mental health, while social perceptions (social trust and social fairness) play a suppressing effect on the relationship between them. The results of further discussion show that the degree of the influence of digital lives on mental health of individuals is heterogeneous among different regions. Due to the difference in development level, the positive impact of digital lives is greater in urban areas than in rural areas, and it is stronger in western regions than in eastern and central regions. This study enriches the nascent research stream of digitalization, explores new paths of harnessing digital technologies for mental health, and offers useful insights for the government to guide them in formulating digital development strategies and achieving the Healthy China Strategy.

KEYWORDS

digital lives, mental health, mediating mechanism, personal perception, social perception

1. Introduction

Mental health is believed to be essential to a happy, satisfying, and meaningful life. It is "an integral part of our general health and wellbeing and a basic human right" (1). The reality, however, is that nearly one billion people worldwide suffered from mental disorders in 2019, and that mental disorders (such as depression and anxiety) are among the top 10 causes of the global burden of disease (2). In addition, the COVID-19 pandemic has taken huge toll on people's mental health. According to the World Health Organization, rates of depression and anxiety went up by more than 25% in the first year of the pandemic.

Beyond mental health itself, the far-reaching effects of digitalization on mental health cannot be ignored (3). Digitalization in our living environment is augmented by the continuous innovation and integrated application of the underlying digital technology. For example, the use of digital media (such as computers, mobile phones, video websites, and social media) has become quite common and has become a new way to access mental health information and support (4). Lockdown and restrictions in movement and social contact due to the COVID-19 pandemic have led to increased reliance on a digital lifestyle, such as accessing health care services (5, 6). While digitalization has a variety of favorable functions, excessive usage of a kind of digital product, such as a smartphone, has the paradoxical effect of diminishing the mental health of its users (7). The relationship between psychological symptoms and the use of Internet and new media is likely to be even more complex than existing study was able to elucidate (8). As such, it is essential to explore the potential impact of digital lives on the overall mental health of people in greater depth.

The previous literature on the relationship between digital lives and mental health was inconclusive, three seemingly arguments exist. The first opinion is that digitalization will promote mental health, as people who use the Internet more frequently have substantially lower odds of having mental health problems (9). The second is that overuse of universal digital technologies or digital products, particularly in the form of addiction to the Internet, will cause disturbances or harm to the individual's mental health (10, 11). The third view holds that there are some indirect impact mechanisms between digitalization and mental health. One is the interpersonal emotion explanation mechanism which holds that aspects of digital lives, including online social activities, leisure, and entertainment, can increase subjective wellbeing and reduce stress and depression levels (12–14). Another is the information acquisition explanation mechanism which holds that many websites can be available to seek mental health information and support online (15, 16).

A literature review reveals that scholars have attempted to understand how digitalization of life is shaping mental health. Nevertheless, the relationship between digital lives and mental health remains unclear. In the further exploration of the influencing mechanism, the existing research mainly takes two approaches: the interpersonal emotion explanation mechanism and the information acquisition explanation mechanism. As individuals in a complex social environment, people's psychological health and wellbeing are related to their social environment to some extent (17). However, the literature on interpersonal emotion has generally focused only on a single dimension—emotion perception at the individual level—ignoring the emotional perception at the social level. In addition, some studies suggest that only a minority of digital users take advantage of digital technology for mental health purposes (18, 19). The Internet seems to be underutilized for information on mental health, and its usage is primarily focused on entertainment, watching media, listening to music, playing games, social communication, and similar activities. Therefore, information access mechanisms do not seem to explain the relationship between digitalization of life and mental health.

Accordingly, our study proposes the following two research questions (RQs):

RQ1: What is the impact of digital lives on mental health?
RQ2: Through what emotion perception mechanism do digital lives influence mental health at multi-dimensions?

To answer these questions, we developed a theoretical model and validated it using data from the Chinese General Social Survey (CGSS), which was carried on the Department of Social Sciences, Renmin University of China in cooperation with the Survey Research Center of the Hong Kong University of Science and Technology. This study makes three theoretical contributions to the literature. First, this paper provides new empirical evidence to further understand digitalization and its impact on mental health, which enriches the research on digital lives and mental health. Second, this paper attempts to clarify the mechanism of the impact of digital lives on mental health from multiple dimensions, including individual perception dimension and social perception dimension, which fill the theoretical gaps in mental health research on digitalization. Third, based on existing research, this paper compares different groups of residents to further clarify the relationship between digital lives and mental health in order to provide a realistic basis for better guidance on using digitalization to enhance the mental health of residents. In addition, this paper has important practical significance. First, this paper offers useful insights for the government and guides the government in formulating digital development strategies and achieving the Healthy China Strategy. Second, this paper provides specific coping methods for residents to make full use of digitalization to maintain their mental health. Third, this paper analyzes the possible shortcomings of social ethics in the context of digital transformation and provides useful ideas for the government to provide mental health intervention measures and related system construction.

The rest of the paper is structured as follows: Section 2 provides theoretical underpinning based on the related literature and presents the hypothesis. Section 3 describes methodology of this study, including data sources, variables selection and measurements. Section 4 presents model selection and the main results. Section 5 provides further discussion based on the results of the full sample and sub-sample, respectively. Section 6 summarizes the research conclusions.

2. Theoretical underpinning and hypothesis development

With digital technology increasingly integrated into our daily lives, digitalization has become a trend, as most daily activities have now gone online (20, 21). In the other words, people can enjoy shopping online, adopt digital payment, work from home, and communicate with others at will without leaving home (22–25). The status of mental health can also be affected by the convenience of digitalization. Although some studies suggest that digitalization could harm the mental wellbeing of the individual (26, 27), this negative digitalization usually refers specifically to problematic Internet use (PIU), which is defined as the excessive use of the Internet, which causes disturbances or harm to the individual (28), for example, through online gaming and cyber pornography. In general, the emerging of digital lives has been contributing to improving the overall condition of mental health (29), which is mainly reflected in in the following two aspects. First, some medical interventions can be delivered *via* digital technologies (30). Due their relatively low cost and ease of scalability, digital health interventions such as apps, digital platforms, and wearables, will help bring access to mental health support (31). Second, there are many benefits of interacting with others through the Internet use. Online communication has become a pathway for family members to maintain relations and share affection (26), and it has become an important way for individuals to receive peer support and to connect with others with similar experiences (32). In sum, digital lives enable individuals to access external mental health support, maintain family ties, and increase interpersonal communication, thereby allowing them to relax and release stress. Following the above analysis, we propose H1:

- H1: Digital lives are positively correlated with the mental health of residents.

With the development of digitalization in people's daily life, such as the application of smartphones, wearables, and sensors, more and more fitness apps have emerged in the market to provide users with personalized, scientifically reasonable fitness plans, meet users' various fitness needs and guide users to adjust according to their actual physical conditions (33, 34). According to recent statistics, the Health and Fitness category accounts for a large proportion of apps in both the Android and Apple app stores—the eighth-largest categories of apps (35). Previous literature has shown that smartphone app usage is one of the most frequently used methods of digital health interventions for enhancing physical activity (36), and the use of apps can increase cognitive patterns encouraging exercise and physical activity, so those who use fitness apps participate in significantly more physical activity than those who do not (37). A growing literature recognizes the positive effects of exercise on emotional states such as anxiety, stress and depression, including helping people with mood disorders achieve better mental health outcomes (38). In actual treatment, mental health practitioners view exercise as an effective evidenced-based intervention for a range of mental health conditions, and they often prescribe exercise regularly to patients who are experiencing anxiety, stress, and depression (39). Various mechanisms have been proposed to explain the positive effect of physical activity on mental health. For instance, exercise may reduce stress hormones and increase the levels of endorphins and brain-derived neurotrophic factor in the body, which could make people feel happy, optimistic, and relaxed. Exercise can also help distract people from stress and improve their ability to control overly stressful situations (40). Following the above analysis, we propose H2a:

- H2a: Digital lives improve mental health of residents by enhancing physical exercise.

Previous studies have found that digitalization of life is closely related to subjective wellbeing, that the use of digital technology can affect wellbeing in different ways, and that it can positively predict subjective wellbeing (41, 42). For example, as a device to support independent living and social activities, the smartphone increases the opportunities to contact with the outside world and enables people to have more social connections and support. In addition to providing users with always-on connectivity, the widespread use of smartphones in daily life affords users access to burgeoning information and a variety of entertainment options. The social use, informational use, and entertainment use of smartphones will greatly enhance people's wellbeing and lead to a more positive attitude toward life (43). Digital lives' contribution to subjective wellbeing has proved to be age-neutral. Children can get playful consumption experience, enjoyment, and sensory experiences (44), and adolescents and older adults can alleviate feelings of loneliness and isolation through online communication (45, 46). Subjective wellbeing at the psychological level, as described above, is often identified as a state of positive mental health. Some studies of the relationship between subjective wellbeing and negative spiritual conditions, such as anxiety and depression, show that there is a significantly inverse correlation between subjective wellbeing and depression, death anxiety, pain interference and other negative psychological conditions (47, 48). Accordingly, the stronger the subjective wellbeing, the better the mental health. In sum, subjective wellbeing is a powerful predictor of mental health, even better than positive changes in outlook (49). In other words, wellbeing can effectively predict mental health. Following the above analysis, we propose H2b:

- H2b: Digital lives improve the mental health of residents by improving subjective wellbeing.

One controversial phenomenon in the digital era is that, while digitalization increases information transparency and improves communication channels, which provides an opportunity to recovery or re-build trust, digitalization is also leading to the decline of trust. There are two main explanations for this. First, the negative effects of information overload on social trust should not be ignored (50). The digitalization of all aspects of life has created a huge amount of information, but due to the existence of information inequality and lack of effective information filtering, individuals in the digital world are easily exposed to misleading news, fraud, and various social scandals (51). Second, incongruency between advertisement shared on social media and the online motivation may increase privacy concerns, which in turn fuel social distrust (52). Social trust levels in the digital context may further influence mental health, current research suggests that the mental health of residents who trust and help each other is significantly higher than that of residents without trust and mutual help (53). In other words, the low level of interpersonal trust in society is one of the important risk factors for mental health (54). A growing body of evidence suggests that interpersonal trust might be associated with mental health outcomes; for example, trust is negatively related to mental illness, and people who have high interpersonal trust are less likely to experience suicidal ideation than those who have low interpersonal trust (55, 56). Therefore, social trust may suppress the positive association between Internet use and mental health. Following the above analysis, we propose H2c:

- H2c: Digital lives endanger the mental health of residents by reducing their sense of social trust.

Inequalities in the distribution of resources and opportunities persist around the world. The advancement of digital technology and digitalization of life will play a significant impact on an individual's perceptions toward these aspects of social fairness. There is evidence that Internet use negatively affects social fairness perceptions directly by channeling their social emotions (57). While information can be easily accessed online, negative news, including the unequal distribution of educational resources, excessive income, large urban-rural gaps, and political corruption, is also widely disseminated through Internet, which may change individual's perceptions of the society where they live, especially the level of social fairness (58). Some people who suffered injustice in real life try to seek justice online by uploading their experience to social media, and the justice-seeking posts will quickly be viewed and shared by thousands of social media users (59), and thus sympathy toward the unfairly treated groups arouses empathy and negative judgment on social fairness. Belief in social fairness has salutary effects for mental health from a wide range of individuals (60); whereas inequality has its most fundamental effects on the prevalence of number of psychopathologies (61) and a statistically significant positive relationship between inequality and risk of depression has been reported (62). Due to the Internet widening the scope of social comparisons, it can generate a sense of relative deprivation and frustration that negatively affects mental health. With the perception of social fairness fades, psychological deficits, including a poor sense of self, unmet needs, and personal trauma, will be generated in the public, which may even trigger hatred in irrational scenarios (63). Following the above analysis, we propose H2d:

- H2d: Digital lives endanger the mental health of residents by weakening a sense of social fairness.

Based on the above research hypotheses, we construct the research framework, as shown in Figure 1.

3. Data sources and specification of variables

3.1. Data sources

The data used in this paper are mainly from the Chinese General Social Survey (CGSS). Specifically, CGSS is a national, comprehensive academic survey that collects data at multiple levels of society, community, family, and individuals. CGSS data are widely used in studies of health and Internet use (64–67). Considering the timeliness and availability of the data, we selected cross-sectional data from the latest released 2017 CGSS as the samples for this study. Independent variables, dependent variables, mediating variables and control variables at the individual and family levels are all derived from the above survey. In addition, part of the control variables at the regional level is collected from the Institute of Digital Finance Peking University. We finally retained 12,085 observations after deleting missing values and outliers and eliminating the data that answered "Not applicable," "Refused to answer," and "Don't know."

3.2. Variables selection

3.2.1. Dependent variable

The dependent variable is mental health of residents, measured by responses to the question, "How often did you feel depressed in the past four weeks?". We assign 1 to "Always," 2 to "Often," 3 to "Sometimes," 4 to "Rarely," and 5 to "Never." The better the mental health, the higher the value.

3.2.2. Independent variable

The independent variable is digital lives, measured by responses to the question, "How often did you use the Internet (including mobile Internet access) in the past year?". We assign 1

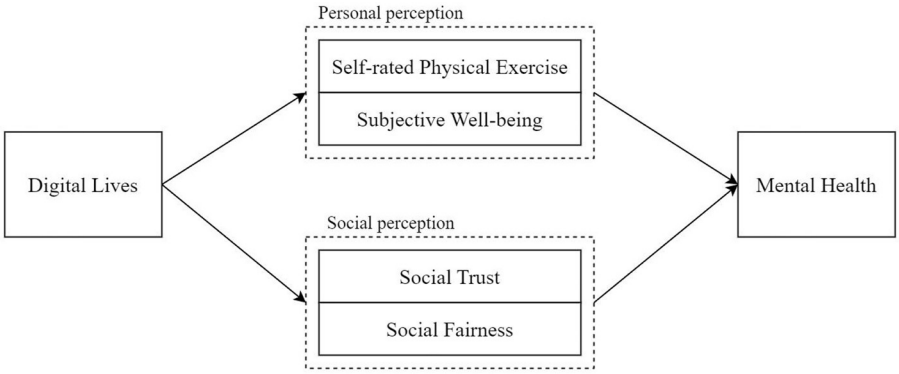

FIGURE 1
Research framework.

to "Never," 2 to "Rarely," 3 to "Sometimes," 4 to "Often," and 5 to "Always." The more frequently the Internet is used (that is, the higher the value), the higher the degree of digitalization of lives.

3.2.3. Mediating variables

The mediating variables in this study are set from two dimensions: personal perception and social perception. Specifically, the mediating variables of the individual perception dimension are self-rated physical exercise and subjective wellbeing. Self-rated physical exercise is measured by responses to the question, "In the past 12 months, how many times per week did you typically engage in 30 min of physical activity that made you sweat?"; and subjective wellbeing is measured by responses to the question, "In general, do you feel your life is happy?" The mediating variables of the social perception dimension are social trust and social fairness. We use the answer to the question, "In general, do you agree that the majority of people in society can be trusted?" as the proxy variable for social trust and the answer to the question, "In general, do you think that today's society is fair?" as a proxy variable for social fairness. Except for self-rated physical exercise is expressed by the frequency of physical exercise filled in by respondents, the values of the other three mediating variables are divided into five levels, ranging from 1 to 5, with the higher values indicating greater senses of happiness, social trust, and justice.

3.2.4. Control variables

The control variables include the individual, family, and regional control variables. We select age, gender, household registration, education level, marital status, and health insurance of respondents as control variables at the individual level, select Internet access status of family members as control variables at the family level, and select the regional digital financial inclusion index as control variables at the regional levels.

The specific definitions and assignments of the variables are shown in Table 1.

3.3. Descriptive statistics

Descriptive statistics and correlations of the variables are shown in Table 2. The average mental health is 3.804, which indicates that resident mental health status is fair but still requires improvement. There is a significant positive correlation between the core variables MH and DL, which preliminarily supports the basic hypothesis of this paper that digital lives have a positive impact on the mental health of residents. In addition, in the process of regression analysis, we have conducted a variance inflation factor test. The results show that the overall VIF mean is 1.51 and the VIF coefficient of each independent variable do not exceed 10, which further indicates that there is no multicollinearity problem in this paper.

4. Model selection and empirical results

4.1. Model selection

To explore the impact of digital lives on mental health, we first used the OLS model to perform a preliminary regression. We then constructed the mediating effect model by adding the mediating variables (Exercise, Happiness, Trust, and Fairness), referring to the mediation effect test procedure proposed by Wen and Ye (68), to test whether digital lives affect mental health through self-rated physical exercise, subjective wellbeing, social trust, and social fairness. The models are set

TABLE 1 Variable definition and assignment.

Variable type	Variable code	Variable assignment
Dependent variable	MH	From 1 to 5, the better the mental health, the higher the value
Independent variable	DL	From 1 to 5, the higher the degree of digitalization of lives, the higher the value
Mediating variables	Exercise	Frequency of physical exercise at least 30 min
	Happiness	From 1 to 5, greater sense of happiness, the higher the value
	Trust	From 1 to 5, greater sense of social trust, the higher the value
	Fairness	From 1 to 5, greater sense of social fairness, the higher the value
Control variables	Age	Survey year minus birth year
	Gender	Male = 1, Female = 0
	Household	Agricultural household registration = 1, Non-agricultural household registration = 0
	Education	From 1 to 13, the higher the level of education, the higher the value
	Married	Married and living with their spouse = 1, Other = 0
	Insurance	Yes = 1, No = 0
	Family	Residents with other family members surfing the Internet = 1, Residents without other family members surfing the Internet = 0
	DFII	Regional digital financial inclusion index

as follows:

$$MH_i = \alpha_1 + \beta_1 DL_i + \gamma_1 CV_i + \varepsilon_i \quad (1)$$

$$M_i = \alpha_2 + \beta_2 DL_i + \gamma_2 CV_i + \varepsilon_i \quad (2)$$

$$MH_i = \alpha_3 + \beta_3 DL_i + \delta M_i + \gamma_3 CV_i + \varepsilon_i \quad (3)$$

Where MH_i represents the mental health status of residents, DL_i represents the degree of digitalization of lives, CV_i represents other factors that affect mental health, and ε_i represents the random disturbance term. β_1 is the coefficient we focus on, reflecting the total direction and extent of the impact of digital lives on mental health. In the mediating effect test, M_i represents the mediating variables. The testing procedures are as follows: Step 1 is to test the coefficient β_1 in Equation (1), and if it is significant, the mediating effect is established, and the follow-up inspections are carried out. Step 2 successively tests β_2 in Equation (2) and δ in Equation (3), and if they are significant, it means that the indirect effect is significant, and then step 4 is carried out; if at least one is not significant, perform step 3 at a later test. Step 3 is to use the Bootstrap method to test the null hypothesis: $\beta_2 \times \delta = 0$, and if it is significant, it indicates that the indirect effect is significant, and then step 4 is carried out. Otherwise, the analysis stops. Step 4 is to test the coefficient β_3 in Equation (3), and if it is not significant, the direct effect is not significant, indicating that the model only has a mediating effect; if it is significant, go to step 5. Step 5 is to compare the signs of $\beta_2 \times \delta$ and β_3, and if the signs are consistent, it means that a partial mediating effect exists, and if the signs are different, it means that a suppressing effect exists.

4.2. Empirical results

The results of the baseline regression are shown in Table 3. In Models (1) and (2), the coefficients of digital lives (DL) are all significantly positive ($p < 0.01$), indicating that the digitalization of lives can effectively improve the mental health of residents. Thus, H1 is supported. Concerning the control variables in Model (2), the results indicate that higher levels of education and development of regional digital financial inclusion are helpful in improving residents' mental health. Compared with women, agricultural household registration residents, unmarried people, and residents without other family members using the Internet, men, non-agricultural household registration residents, married people, and residents who have family members using the Internet have advantages in the impact of digital lives on mental health.

4.3. Robustness test

In this study, we adopt two methods to test the robustness of the baseline regression results. The first method is to use the ordered logit model for regression, considering that mental health is typical ordinal data. The second method is to replace the original independent variable by whether to use Alipay or WeChat payment, because the adoption of electronic payment means can also reflect the degree of digitalization of a person's life to a certain extent. In Table 4, Model (1) is the Ologit estimation results of the impact of digital lives on mental health. Model (2) and Model (3) are the OLS estimation results under the substitution variable method, respectively. Among them, Digital1 represents whether WeChat payment has been used. If the answer is yes, it is 1; otherwise, it is 0. Digital2 represents whether Alipay has been used. If the answer is yes, it is 1; otherwise, it is 0. It can be seen from Table 4 that the coefficients of independent variables in three models are all significantly positive, indicating that the estimated result is still robust.

TABLE 2 Descriptive statistics and correlation coefficient matrix of variables.

	(1) MH	(2) DL	(3) Exercise	(4) Happiness	(5) Trust	(6) Fairness	(7) Age	(8) Gender	(9) Household	(10) Education	(11) Married	(12) Insurance	(13) Family	(14) DFII
(1)	1													
(2)	0.158***	1												
(3)	0.130***	0.122***	1											
(4)	0.316***	0.093***	0.118***	1										
(5)	0.082***	−0.100***	0.019**	0.174***	1									
(6)	0.125***	−0.096***	0.016*	0.296***	0.308***	1								
(7)	−0.060***	−0.640***	0.023**	0.017*	0.136***	0.122***	1							
(8)	0.062***	0.036***	0.039***	−0.034***	0.00400	0.020**	0.0100	1						
(9)	−0.157***	−0.283***	−0.212***	−0.118***	0.0100	−0.00300	−0.027***	−0.00700	1					
(10)	0.168***	0.594***	0.148***	0.134***	−0.019**	−0.0110	−0.461***	0.096***	−0.454***	1				
(11)	0.044***	−0.045***	−0.010	0.062***	0.020**	−0.025***	0.085***	0.0100	0.047***	−0.121***	1			
(12)	0.010	0.000	0.017*	0.051***	0.033***	0.028***	0.044***	0.00300	−0.018*	0.035***	0.066***	1		
(13)	0.101***	0.433***	0.084***	0.103***	−0.049***	−0.061***	−0.329***	−0.041***	−0.161***	0.288***	0.032***	0.027***	1	
(14)	0.169***	0.225***	0.139***	0.096***	−0.016*	−0.034***	0.030***	−0.00600	−0.369***	0.262***	−0.034***	0.0130	0.136***	1
Mean	3.804	2.831	2.085	3.864	3.465	3.1	50.769	0.472	0.538	5.195	0.78	0.924	0.774	282.154
Std. Dev.	0.996	1.721	3.035	0.848	1.031	1.064	16.658	0.499	0.499	3.275	0.415	0.266	0.418	27.679

***p < 0.01, **p < 0.05, *p < 0.1.

10.3389/fpubh.2022.1085256

TABLE 3 Baseline regression results.

Variable	(1) MH	(2) MH
DL	0.0917***	0.0442***
	(0.0052)	(0.0080)
Age		0.0012
		(0.0008)
Gender		0.1072***
		(0.0178)
Household		−0.1226***
		(0.0217)
Education		0.0209***
		(0.0037)
Married		0.1416***
		(0.0217)
Insurance		−0.0018
		(0.0343)
Family		0.0718***
		(0.0244)
DFII		0.0039***
		(0.0004)
Constant	3.5441***	2.2552***
	(0.0179)	(0.1162)
Observations	12,085	12,085
R-squared	0.0251	0.0594

Robust standard errors in parentheses, ***p < 0.01.

TABLE 4 Robustness test.

Variable	(1) MH	(2) MH	(3) MH
DL	0.0825***		
	(0.0153)		
Digital1		0.0914***	
		(0.0268)	
Digital2			0.0670**
			(0.0264)
Age	0.0031**	0.0005	−0.0001
	(0.0015)	(0.0008)	(0.0008)
Gender	0.2142***	0.1093***	0.1099***
	(0.0337)	(0.0178)	(0.0178)
Household	−0.2242***	−0.1361***	−0.1398***
	(0.0406)	(0.0216)	(0.0215)
Education	0.0402***	0.0233***	0.0237***
	(0.0071)	(0.0037)	(0.0037)
Married	0.2807***	0.1478***	0.1502***
	(0.0406)	(0.0217)	(0.0218)
Insurance	−0.0229	−0.0058	−0.0053
	(0.0657)	(0.0344)	(0.0344)
Family	0.1262***	0.0902***	0.0965***
	(0.0451)	(0.0240)	(0.0238)
DFII	0.0088***	0.0041***	0.0041***
	(0.0007)	(0.0004)	(0.0004)
/cut1	−0.8173***		
	(0.2357)		
/cut2	1.0883***		
	(0.2280)		
/cut3	2.7686***		
	(0.2287)		
/cut4	4.3362***		
	(0.2317)		
Constant		2.3153***	2.3471***
		(0.1162)	(0.1153)
Observations	12,085	12,036	12,036
R-squared/Pseudo R2	0.0243	0.0578	0.0574

Robust standard errors in parentheses, ***p < 0.01, **p < 0.05.

4.4. Mediating effects test

Table 5 reports the mediating effects of self-rated physical exercise, subjective wellbeing, social trust, and social fairness. The test result of step 1 in column (1) of Table 5 shows that the coefficient of DL is positive and significant at the 1% level, which means that there is a mediating effect on the impact of digital lives on residents' mental health. In the sequential test of step 2, we find that the variable "DL" has a significant effect on the four mediating variables. The results from columns (2) through (5), respectively, show that the improvement of the degree of digital lives increases personal physical exercise and happiness, while exacerbating social distrust and social unfairness. At the same time, the coefficients of the four mediating variables in column (6) are still significant, indicating that the indirect effects of mediating variables are significant. Based on the results of step 2, we skip to step 4 for inspection. The coefficient of DL in column (6) is still significantly positive and lower than that in column (1) after adding the four mediating variables. The result shows that direct effects are significant and that digital lives can influence residents' mental health through self-rated physical exercise, subjective wellbeing, social trust, and social fairness. Finally, we perform step 5 to compare the signs of coefficients. The sign of the product of DL's coefficient in column (2) and Exercise's coefficient in column (6), the sign of the product of DL's coefficient in column (3) and Happiness's coefficient in column (6) are consistent with the sign of DL's coefficient in column (6), indicating that self-rated physical exercise and subjective wellbeing are considered to play a partial mediating role in the relationship between digital lives and mental health. This also means that digital lives can improve the mental health of residents by promoting physical activity and increasing wellbeing. Undergoing similar analysis, the sign of the product

TABLE 5 Mediating effects test.

Variable	(1) MH	(2) Exercise	(3) Happiness	(4) Trust	(5) Fairness	(6) MH
DL	0.0442***	0.1776***	0.0302***	−0.0274***	−0.0299***	0.0336***
	(0.0080)	(0.0252)	(0.0068)	(0.0086)	(0.0089)	(0.0077)
Exercise						0.0197***
						(0.0029)
Happiness						0.3105***
						(0.0118)
Trust						0.0316***
						(0.0093)
Fairness						0.0468***
						(0.0093)
Age	0.0012	0.0223***	0.0068***	0.0096***	0.0085***	−0.0021***
	(0.0008)	(0.0024)	(0.0007)	(0.0008)	(0.0008)	(0.0007)
Gender	0.1072***	0.1762***	−0.0821***	−0.0120	0.0237	0.1286***
	(0.0178)	(0.0543)	(0.0152)	(0.0188)	(0.0193)	(0.0170)
Household	−0.1226***	−0.7911***	−0.0272	0.0833***	0.0284	−0.1025***
	(0.0217)	(0.0683)	(0.0189)	(0.0230)	(0.0235)	(0.0207)
Education	0.0209***	0.0548***	0.0352***	0.0334***	0.0311***	0.0064*
	(0.0037)	(0.0115)	(0.0031)	(0.0040)	(0.0041)	(0.0036)
Married	0.1416***	−0.0212	0.1376***	0.0325	−0.0776***	0.1019***
	(0.0217)	(0.0652)	(0.0196)	(0.0224)	(0.0231)	(0.0205)
Insurance	−0.0018	0.0656	0.1073***	0.0873**	0.0893**	−0.0433
	(0.0343)	(0.0966)	(0.0315)	(0.0368)	(0.0369)	(0.0324)
Family	0.0718***	0.2776***	0.1428***	0.0001	−0.0357	0.0237
	(0.0244)	(0.0710)	(0.0219)	(0.0247)	(0.0259)	(0.0232)
DFII	0.0039***	0.0049***	0.0009***	−0.0009**	−0.0018***	0.0037***
	(0.0004)	(0.0011)	(0.0003)	(0.0004)	(0.0004)	(0.0003)
Constant	2.2552***	−1.1269***	2.7415***	2.9841***	3.0743***	1.1880***
	(0.1162)	(0.3623)	(0.0989)	(0.1225)	(0.1245)	(0.1172)
Observations	12,085	12,085	12,085	12,085	12,085	12,085
R-squared	0.0594	0.0620	0.0456	0.0255	0.0238	0.1470

Robust standard errors in parentheses, $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

of DL's coefficient in column (4) and Trust's coefficient in column (6), the sign of the product of DL's coefficient in column (5) and Fairness's coefficient in column (6) are different from the sign of DL's coefficient in column (6), indicating that social trust and social fairness are considered to play a suppressing effect on the relationship between digital lives and mental health. This also means that digital lives will have a negative impact on mental health of residents by reducing the sense of social trust and social fairness. To sum up, H2a, H2b, H2c, and H2d are supported.

5. Further discussion

Across these mental health outcomes, more exposure to digital lives translates to fewer psychological symptoms, and digital lives could indirectly influence mental health from the personal perception dimension and the social perception dimension, which is consistent with some previous findings (69, 70).

The above results are only the average effect of the whole sample analysis, and the differences among different groups are not considered. Given that the degrees of digitalization of life may be various in different resources and environments, the impacts of digital lives on residents' health may be heterogeneous in different regions. We selected economic regionalization and household registration types to divide the sample into groups for further discussion. Table 6 reports the regression results of the subgroup samples. Models (1) and (2) show that digital lives have a significant positive impact on mental health in both urban and rural areas, but in terms of

TABLE 6 The regression results of the subgroup samples.

Variable	(1) MH	(2) MH	(3) MH	(4) MH	(5) MH
	Rural area	Urban area	Eastern region	Central region	Western region
DL	0.0349***	0.0459***	0.0333***	0.0355**	0.0505***
	(0.0115)	(0.0113)	(0.0117)	(0.0140)	(0.0179)
Control variables	Yes	Yes	Yes	Yes	Yes
Constant	2.2679***	2.2530***	2.7661***	4.0494***	2.2911***
	(0.1946)	(0.1413)	(0.1839)	(0.4850)	(0.5956)
Observations	6,496	5,589	5,425	3,847	2,813
R-squared	0.0470	0.0339	0.0275	0.0419	0.0498

Robust standard errors in parentheses, $^{***}p < 0.01$, $^{**}p < 0.05$.

the coefficient values, the positive impact is greater in urban areas than in rural areas. One explanation for this result is that people living in urban areas are more prone to experiencing loneliness than those living in rural areas (69), and urban residents affected by digitalization get more emotional support through online channels, thereby improving their mental health more greatly. Similarly, Model (3) through (5) reflect that the positive impact of digital lives on mental health is stronger in the group of western regions, compared with the eastern and central regions. That may be related to differences in connectivity and mobility caused by economic conditions (9). The residents in the more developed eastern and central regions have higher income levels, and could easily connect with friends and engage in a variety of entertainment forms, even without digital channels. However, these are scarce in the economically underdeveloped western regions. Consequently, digital lives can enable residents in western regions to enjoy more positive mood, which is conducive to alleviating negative emotions and promoting mental health.

6. Conclusion

This study empirically examined the impact of digital lives on mental health of residents as well as the underlying mechanism based on the data of CGSS in 2017. The results indicate that the penetration of digitalization in daily life has a directly positive impact on the maintenance of mental health of residents. In addition, the analysis of the mediating effect model identifies personal perception and social perception as the important path mechanisms for digital lives to affect mental health. Self-rated physical exercise and subjective wellbeing in personal perception demission play a partial mediating role in the relationship between them; however, social trust and social fairness in social perception have a suppressing effect on the relationship between them. The results of further discussion show that the degree of influence of digital lives on the mental health of individuals is heterogeneous among different regions. Due to the difference in development levels, the positive impact of digital lives is greater in urban areas than in rural areas and is stronger in the western regions than in the eastern and central regions.

Based on the above research conclusions, we make the following suggestions. First, the government should further strengthen the construction of digital infrastructure and improve the digital penetration, and especially narrow the regional digital divide, thereby increasing the opportunities for every citizen to access to digitalization, which could fully leverage the positive effects of digital lives on mental health and achieve the strategic objective of Healthy China Strategy. Second, the government should also encourage the application of digital technology and develop the digital economy consistently, thus inspiring the positive influence of digital lives on mental health for individuals, such as accessing more mental health support, contacting to friends and family members at any time, getting more recreational and leisure activities, increasing subjective wellbeing. Third, be aware of the importance of maintaining a sound digital environment. In particularly, regulatory authorities should strengthen the control and supervision of Internet media and actively guide the correct value and behavioral norms to weaken the transmission mechanisms that digital lives have a negative impact on the perception of social trust and fairness.

This study still has several limitations, which should be made further breakthroughs in the future. First, this study examined the relationship between digital lives and mental health based on cross-sectional data, which could not capture the dynamic development of mental health very well. Future research can select continuous survey data from multiple years to explore their relationship. Second, this study was conducted with populations in China, and the generalizability of the research findings is limited by the sample size and country sources. Future research can extend our study to greater numbers of respondents from other regions and countries.

Finally, due to the availability of data, this study was unable to explore the impact of digital lives on the mental health of residents during the COVID-19 pandemic and in the post-pandemic era. Future research can take the COVID-19 epidemic as an external environmental factor to explore its moderating effect on the relationship between digitalization and mental health.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

YC: conceptualization, methodology, and writing—original draft. MW: data collection, software, formal analysis, and writing—review and editing. JO: revised the paper. All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Acknowledgments

We acknowledge the financial support from the National Natural Science Foundation of China (Grant No. 72172018) and the Chinese Academy of Engineering (Grant No. 2022-XBZD-03).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 05 January 2023
DOI 10.3389/fpubh.2022.1070947

OPEN ACCESS

EDITED BY
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SPECIALTY SECTION
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

RECEIVED 15 October 2022
ACCEPTED 12 December 2022
PUBLISHED 05 January 2023

CITATION
Zhao Y, Jin X, Zhao T and Li J (2023) Escape from self: Stress increase consumers' preference for experiences over material possessions. *Front. Public Health* 10:1070947. doi: 10.3389/fpubh.2022.1070947

Escape from self: Stress increase consumers' preference for experiences over material possessions

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Introduction: Considering the theory of self-escape, this research systematically investigates the effect of stress on consumers' preference for experiences vs. material possessions.

Methods: We conducted one survey and two experiments to demonstrate the effect of stress on individuals' relative preference for experiential vs. material consumption and its psychological mechanism.

Results: The findings of the three studies revealed that stress increases consumers' preference for experiences over material possessions. Additionally, self-escape motivation plays a mediating role between stress and preference for experiential consumption (vs. material consumption). Stress as a self-threat triggers individuals' motivation to escape from negative self-concept, and experiences can help individuals temporarily escape from negative self-recognition and provide more leisure value than material possessions. Therefore, individuals increase their consumption preference for experiences. Furthermore, we observed that the type of experiences plays a moderating role between stress and preference for experiential consumption (vs. material consumption). Specifically, compared with low cognitive resource demanding experiences, the effect of stress on experiential consumption disappears when experiences have a high demand for cognitive resources.

Discussion: These findings extend the research on stress, experiential consumption and material consumption and provide significant advice for public mental health.

KEYWORDS

stress, self-escape, experiential consumption, material consumption, cognitive resources

1. Introduction

Stress has become a common psychological state of modern individuals. According to data from Gallup's sentiment survey in 2021, the global stress level reached an all-time high–40%. Stress is a negative psychology that propels individuals to cope in various ways. One common way to deal with stress is through consumer behavior. Exiting research has explored the impact of stress on material products, such as luxury goods

(1–3) and unhealthy foods (4), few studies have focused on the impact of stress on experiential products. A survey of office workers from China revealed that ∼70% would prefer to travel as their main choice when experiencing stress. In addition, the survey report highlighted that 12% would prefer to watch a concert, and 10% would prefer to watch a movie, reflecting that stressed individuals desire experiential consumption, which provides a new idea for relevant research. However, the relationship between stress and consumption preference for experiences remains unclear. Considering that experiential consumption and material consumption are relative concepts in the field of consumption (5), we raise the following questions based on the above phenomenon and research gaps: Does stress affect an individual's consumption preference for experiences and material possessions? What is the psychological mechanism between them? Does the effect always exist?

Our study introduces the theory of self-escape to explore these issues. Previous studies have found that stress immerses an individual's mind in stressful situations, thereby enhancing the individual's persistent belief that they are unable to cope with environmental demands and reinforces the individual's negative self-perception. In this case, individuals will have a predisposition tendency to avoid self-perception, i.e., self-escape motivation, as a result of their self-defense instinct. Compared with material consumption, experiential consumption can help individuals divert their attention, and temporarily separate from stressful situations, thereby reducing negative self-perception. Consequently, individuals will increase their consumption preference for experiences. By examining the above-mentioned aspects, our study clarifies the relationship between stress and consumption preference for experiences and material possessions, and further reveals that self-escape motivation acts as a significant factor influencing the consumption of experiences. Finally, the paper concludes with the identification of suggestions for public mental health and puts forward prospects for future research in related fields.

2. Theoretical framework

2.1. Stress

Stress is an emotional state frequently experienced by individuals; it generally refers to a state of psychological tension that individuals experience in work, life, interpersonal relationships, and personal responsibilities. It can occur when individuals perceive their environmental demands to be taxing or beyond their available coping resources, thereby endangering their overall wellbeing (6). As a negative psychological state, stress motivates individuals to undertake various coping measures (7, 8). Using consumption to cope with stress has become relatively common. For example, previous studies have deduced that in response to stress, consumers may have a stronger preference for compulsive purchases and impulsive purchases (9) to relieve stress and negative emotions (10), enhance excitement and pleasure (11), and evoke hedonism (12). In addition, research suggests that stress increases individuals' consumption preference for nostalgic products. By recalling people or events in the past through nostalgic consumption, individuals can maintain positive self-evaluation and social support, thereby increasing positive emotions and alleviating current stress (13). Furthermore, previous literature has shown that when consumers feel stressed, their consumption behaviors are aimed at reducing the negative emotional distress and improving their emotions through consumption. Therefore, our study proposes that the consumption of experiences may also help consumers achieve the same purpose.

2.2. Stress and consumption preference for experiences vs. material possessions

Experiential and material consumption are two relative concepts (5). Experiential consumption refers to the consumption performed with the primary intention of acquiring life experiences, emphasizing "process and experience," such as traveling and going to theme parks (14). Material consumption refers to the consumption performed with the primary intention of obtaining material possessions, emphasizing "preservation and possession," such as electronic products. Previous studies have predominantly focused on the distinction between the outcome variables of experiential and material consumption. For example, compared with material consumption, experiential consumption is perceived to be more unique (15), more able to assist individuals develop their ideal-self (16), and offers greater happiness to individuals (1–3). Conversely, material consumption is more likely to be recognized by others than experiential consumption; therefore, it can satisfy the material and symbolic needs of individuals (17). However, limited studies have focused on the factors that affect individuals' relative preferences for experiential and material consumption.

This study explores the effect of stress on individuals' preference for experiential vs. material consumption. In response to stress, individuals typically cope by pursuing positive emotions and avoiding the interference of negative emotions (18). Prior research has demonstrated that the consumption of experiences can generate more sustained happiness than material possessions (19, 20). As a result of this finding, the consumption of experiences (vs. material possessions) has become an effective strategy that helps individuals relieve the negative effects of stress. Therefore, in response to stress, individuals may be more inclined to undertake experiential rather than material consumption to alleviate negative emotions and achieve leisure. Consequently, we hypothesize the following:

Hypothesis 1: Stress will increase individuals' consumption preference for experiences over material possessions.

2.3. Mediating role of self-escape motivation

Self-escape theory describes an individual's desire to escape from negative self-perceptions (21). When an individual has a negative self-perception and cannot resolve it, self-escape motivation occurs (22). Stress can increase an individual's self-escape motivation. From a direct perspective, stress immerses an individual's mind in stressful situations (23), thereby enhancing the individual's persistent belief that they are unable to cope with environmental demands. This reinforces the individual's negative self-perception and increases their cognitive load. Individuals will have a predisposition tendency to avoid self-consciousness, i.e., self-escape motivation, as a result of their self-defense instinct (24). From an indirect perspective, previous studies have determined that stress is often regarded as a threat by individuals, thus triggering anxiety (25). Therefore, emotions are an important signal for interpreting individual motivation and behavior. According to the cognitive-motivational-relational theory of emotion, anxiety reflects an individual's motivation to avoid potential threats and the tendency to flee (26). Whether from a direct or indirect perspective, stress can stimulate an individual's self-escape motivation. Therefore, we hypothesize the following:

Hypothesis 2: Stress increases an individual's motivation to escape from the self.

There are several ways to escape from the self. Existing research has indicated that drinking, overeating, and even suicide are all self-escape mechanisms (27, 28). Therefore, an individual escapes from the self mainly by diverting attention and disengaging from stressful situations. However, these methods negatively impact the individual. In this study, we propose that the consumption of experiences can be regarded as a form of happy escape. Experiential consumption is a consumption pattern wherein individuals engage in experiences (5). Therefore, through experiential consumption, individuals can divert their attention, increasingly focus on experiences (29), and temporarily separate from stressful situations (30), thereby reducing negative self-awareness and creating leisure (31). Previous research has also deduced that stress increases individuals' preference for risky experiences. Consequently, individuals can fully devote their attention to the activity and avoid stress (32). Research about tourism has also found that one of the key motives for individuals to travel is to escape from daily life (1–3, 33, 34). In addition, compared with material possessions, participating in experiences can help individuals construct an ideal-self (16), which increases their positive self-evaluation. Therefore, the dual benefits of reducing negative self-perceptions and building positive self-perception make experiential (vs. material) consumption an effective strategy of helping individuals escape. Thus, the self-escape motivation makes individuals more inclined toward consuming experiences rather than material possessions. Therefore, we hypothesize as follows:

Hypothesis 3: Self-escape motivation increases the individual's consumption preference for experiences (vs. material possessions).

Stress can trigger individuals' motivation to escape from negative self-perception, and experiences can facilitate the temporary escape from negative self-perception and provide more happiness and leisure value than material possessions. Consequently, individuals increase their consumption preference for experiences (vs. material possessions) to achieve temporary leisure and relief. Therefore, we hypothesize the following:

Hypothesis 4: Self-escape motivation plays a mediating role between stress and individuals' consumption preference for experiences (vs. material possessions).

2.4. Boundary condition

It is difficult to reduce individuals' negative self-awareness, as self-escape implies both diverting attention and narrowing it to the current environmental stimuli. Moreover, the concept of self-escape further implies avoiding meaningful thinking (35), i.e., a low construal level of attention demand. While most experiences are more relaxing and leisurely than material consumption, there are also unusual cases where the process of experiences is more complicated and consumes more psychological resources (e.g., intellectual games). In this case, experiences that consume significant psychological cognitive resources may aggravate individuals' cognitive burden, strengthen their negative self-perceptions, and deepen the negative impact of stress. Based on these inferences, we propose the boundary condition for the effect of stress on consumption preference for experiences (vs. material possessions)—the type of experiences. Specifically, individuals should only prefer low cognitive resource–demanding experiences that can facilitate the removal of psychological burdens and increase leisure. When experiences have a high demand for cognitive resources, the effect of stress on experiences disappears. Therefore, we hypothesize the following:

Hypothesis 5: The type of experiences plays a moderating role between stress and consumption preference for experiences (vs. material possessions). Compared with experiences with low cognitive resource demands, the effect of stress on consumption preference for experiences disappears when such experiences have high demands for cognitive resources.

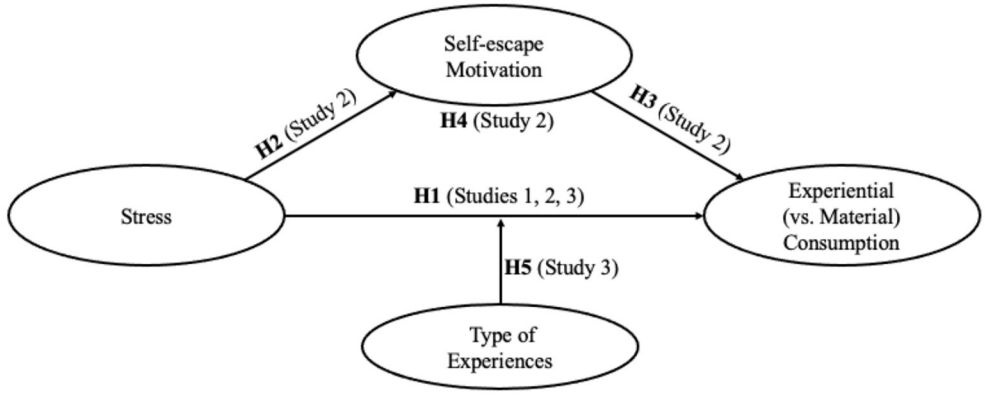

FIGURE 1
Conceptual framework and outline of the studies and hypotheses.

2.5. Overview of studies

We conducted three studies to assess our conceptualization of how stress influences individuals' consumption preference for experiences vs. material possessions as well as the boundary conditions discussed above. We measured (Study 1) and manipulated (Studies 2–3) feelings of stress. In Study 1, we measured participants' perceived stress and their consumption preference for experiences vs. material possessions. The study confirms that individuals with high stress levels have a high consumption preference for experiences (vs. material possessions), thereby providing initial support for the main effect of stress on experiential (vs. material) consumption. In Study 2, we replicated the effect of stress on experiential (vs. material) consumption under laboratory conditions. In addition, we manipulated stress and then used the binary choices between experiential products and material products to intuitively reflect participants' consumption preference. Furthermore, we also tested the mediation effect of self-escape motivation. In Study 3, we highlighted a boundary condition: if experiences do not provide escape effect, i.e., when experiences consume more psychological cognitive resources, the effect of stress on individuals' consumption preference for experiential options will disappear. All product choices used in the three studies were pretested. Figure 1 conceptually summarizes the hypotheses and empirical plan.

3. Study 1

Study 1 aimed to test our basic hypothesis that stress influences individuals' consumption preferences for experiences vs. material possessions. We used online questionnaires to measure individuals' daily stress levels and relative consumption preferences for experiences vs. material possessions. We expected a direct correlation between increase in stress levels and increase in preferences for experiential consumption over material consumption.

3.1. Participants

Study 1 collected 253 valid questionnaires (with a recovery rate of 98.1%) from a professional platform named Credamo. The sample included 147 female participants (58.1%) and 106 male participants (41.9%), aged 19–58 (Mean = 28.3). A significant number of participants had a large share in expenditure, between 2,000 and 3,000 RMB per month (33.2%), and 67.2% of the participants had completed a college or university program.

3.2. Methods

When establishing the questionnaire, we selected representative scales to measure the stress and experiential vs. material consumption preference, which were widely used in previous studies. The questionnaire has passed the audit of Credamo, which guaranteed that it would not cause negative psychological effects on participants. As for the consent of participation, only those who agreed and volunteered to participate in surveys will access the questionnaire and corresponding remuneration. At the beginning of the questionnaire, we once again emphasized that "the survey results are only used for academic research, and the personal privacy of participants will be protected. If you agree and are

participating voluntarily, start answering questions; if you disagree or are unsure, please exit."

The online questionnaire survey comprised two parts: daily life survey and consumer preference survey. After reading the questionnaire description and providing their consent, participants first completed the daily life survey. This survey measured participants' daily life stress based on the research of Lee et al. (36), which consists of five items (Cronbach's $\alpha = 0.74$). The content of the five items was as follows: "My life was very stressful," "Problems experienced by others put an extra burden on me," "I have to deal with a lot of problems on a daily basis," "Relatives or co-workers expected a lot from me," and "I am worried about a lot of things." Participants were required to answer to what extent these statements aligned with their actual conditions. All items used a seven-point Likert scale (ranging from 1 = very inconsistent to 7 = very consistent).

Subsequently, participants were required to complete the consumer preference survey. In this section, we measured participants' relative preference for experiential vs. material consumption based on the research of Howell et al. (37), which consists of four items (Cronbach's $\alpha = 0.70$). The content of four items included "In general, when I have extra money I am likely to buy a material item or a life experience," "When I want to be happy, I am more likely to spend my money on material goods or activities and events," and so on. Additionally, all items used a seven-point Likert scale. Finally, we collected participants' demographic information. Each participant who completed the questionnaire received a 5 RMB.

3.3. Results

We established a stepwise regression to verify the establishment of the main effect between stress and individuals' consumption preferences for experiences vs. material possessions. In the regression model, the participants' gender, age, average monthly expenditure, and education level were placed into Model 1 as control variables, stress was placed into Model 2 as an independent variable, and experiential (vs. material) consumption preference was the dependent variable. The empirical results revealed that the regression coefficient of stress on experiential (vs. material) consumption preference is significant ($\beta = 0.19$, $p = 0.003$), and the delta R-squared of Model 2 on the basis of Model 1 is significant ($\Delta R^2 = 0.03$, $p < 0.001$). This finding implies that stress had a significant positive effect on participants' preference for experiential (vs. material) consumption. That is, the greater stress experienced by participants, the more they prefer experiences over material possessions. Thus, H1 was verified. Additionally, we also found a positive correlation between monthly average expenditure and experiential (vs. material) consumption preference ($\beta = 0.17$, $p = 0.010$), and a negative correlation between educational level and experiential consumption preference ($\beta = 0.16$, $p = 0.016$). Moreover, age and gender had no significant effect on the participant's consumption preference ($p > 0.1$).

3.4. Discussion

The results of Study 1 showed that individuals' stress levels are positively correlated with their consumption preference for experiences (vs. material possessions), which provide preliminary empirical support for our hypothesis. However, Study 1 has several limitations. First, the stress measurements in this study are calculated from participants' indirect feedback, rather than participants' direct and subjective stress; thus, there may be content deviations. Second, as this study was conducted in the form of online questionnaires, the results of regression analysis can only prove the correlation between the two variables, making it difficult to determine the causal relationship between stress and individuals' consumption preference for experiences (vs. material possessions). Therefore, in Study 2, we will conduct an experiment to solve these problems.

4. Study 2

Study 2 aimed to replicate Study 1 in a controlled laboratory environment to establish a robust causal relationship between stress and consumption preferences for experiences vs. material possessions and test the mediation effect. We manipulated participants' stress, and then measured participants' choices between five pairs of experiential and material products and self-escape motivation to examine the relationship between stress and experiential (vs. material) consumption preferences.

4.1. Participants

Participants comprised 102 undergraduate students recruited from a large university in China (56 males, 46 females; $M_{age} = 19.77$). Each participant received 10 RMB as compensation.

4.2. Procedure and stimuli

We conducted the experiment in a lab. Participants were told to complete two separate tasks. The first was a recall task testing their memory, which we in fact used to manipulate stress. The second was a hypothetical shopping task, which we in fact used to measure preference for experiences vs. material goods. The participants were blind to the aims of both tasks.

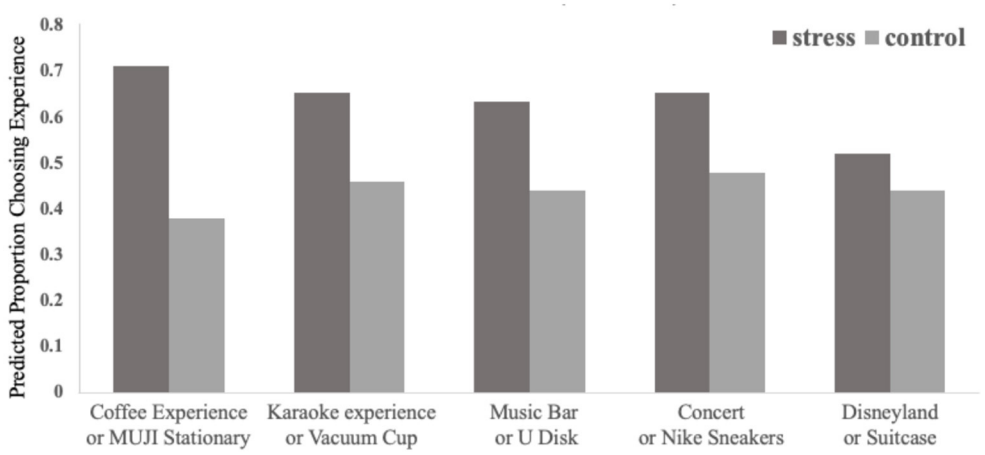

FIGURE 2
Proportion of participants choosing the experiential option, across five replicates, by condition (study 2).

4.2.1. Stress manipulation

First, the participants completed an event recall task to manipulate their stress levels. All participants were instructed that the study's purpose was to collect information regarding general life events. They were asked to write about one type of event, to which they would then be assigned randomly. In the stress condition, the participants were asked to describe a stressful situation they had experienced, whereas in the control condition, they were instructed to write about a typical school day.

4.2.2. Dependent variable

Following completion of the event recall task, participants' preference for experiences vs. material goods was measured using the method adopted from the study conducted by Tully et al. (38). Participants were instructed to choose between five pairs of products with the same price, each consisting of one "experience" and one "material good." For each pair, the participants indicated their preferred products using a binary choice. We randomized both the order of the five pairs and the position of the "material good" and "experience" within each pair. The same randomization procedure was followed in subsequent studies. Additionally, we conducted a separate test to measure the participant's perception of each pair of products and eliminate the influence of confounding factors. The test results revealed that apart from the difference in form, there is no difference between the uniqueness and attractiveness of two products in each pair.

Subsequently, the participants were instructed to indicate how accurate were the following statements in describing their feelings while recalling events: "I find it hard to relax," "I am in a state of nervous tension," "I feel that I am rather touchy," and "I feel stressed" (39). All items used a seven-point Likert scale (ranging from 1 = strongly disagree to 7 = strongly agree). The scores were averaged to form an overall stress index ($\alpha = 0.86$).

Finally, participants were instructed to indicate the extent to which they agreed on a seven-point Likert scale, with four statements measuring the escape motivation provoked by the event they had described. The statements were as follows: "I want to get rid of some dutched-up feelings," "I would attempt to release or reduce some built-up tensions," "I want to have my mind move at a slower pace" and "I want to give my mind a rest" (40). The statements were averaged to form an index of participants' escape motivation ($\alpha = 0.78$).

4.3. Results

4.3.1. Manipulation check

We first tested whether the manipulation of stress was successful. The results revealed that the manipulation caused increased stress levels in participants: those who recalled stressful events reported significantly higher feelings of stress than those in the control condition [$M_{stress} = 4.35$, $M_{control} = 3.42$, $t_{(100)} = 3.491$, $p = 0.001$]. This finding confirms that the stress manipulation was effective.

4.3.2. Consumer preference

We summed the number of experiential products that each participant chose (for a possible score from 0 to 5) and coded this number as each participant's relative preference for experiential goods vs. material goods. As predicted, participants in the stress condition showed greater preference for experiential goods than those in the control condition [$M_{stress} = 3.17$,

$M_{control}$ = 2.20, $t_{(100)}$ = 4.285, $p < 0.001$]. Figure 2 shows participants' preference for the experiential good in each pair at different conditions. Therefore, Study 2 replicated the results of Study 1.

4.3.3. Mediation analysis

As predicted, participants in the stress condition were more motivated to escape than those in the control condition [M_{stress} = 5.00, $M_{control}$ = 4.21, $t_{(100)}$ = 2.607, p = 0.011], and self-escape motivation significantly predicted preference for the experiential goods [β = 0.339, $t_{(100)}$ = 3.60, $p < 0.001$]. This suggests that self-escape motivation may play a mediating role in the effect of stress on preference for experiential purchases. To verify the mediating effect of self-escape motivation between stress and the preference for experiential consumption, we employed a bootstrapping procedure (41). This procedure computed a 95% confidence interval (CI) for the indirect and direct effects through 5,000 sampling. If a CI does not include 0, it indicates that the effect is significant. Following the approach suggested by Hayes (42), participants' preferences served as the dependent variable, the stress condition (coded −1 = control, 1 = stress) was included as the independent variable, and mean-centered motivation to escape was the mediating variable. The results revealed that self-escape motivation mediates the positive relationship between stress and preference for experiential goods [Effect = 0.0797, SE = 0.0394, 95% CI: (0.0205, 0.1853)].

4.4. Discussion

The results of study 2 showed that consumers who are highly stressed have an increased preference for experiences over material goods and this effect was mediated by a heightened motivation to escape from the psychological burden. Thus, Study 2 provides causal evidence that stress motivates individuals to escape, which subsequently increases their consumption preference for experiences over material possessions. While experiences facilitate the escape from psychological burdens rather than material possessions in most cases, there are some exceptions. This suggests a clear boundary condition for the effect. Study 3 will test this proposed boundary condition.

5. Study 3

Study 3 employed a 2 (stress: stress vs. control) * 2 (experiences: high cognitive resource–demanding vs. low cognitive resource–demanding) between-subjects design. We predicted that stress would not increase participants' preference for high cognitive resource–demanding experiential options as they cannot help consumers escape from the psychological burden caused by stress.

5.1. Participants

The participants comprised 209 undergraduate students recruited from a large university in China (101 males, 108 females; M_{age} = 19.34). Each participant received 10 RMB as compensation.

5.2. Procedure and stimuli

Study 3 was conducted in the lab. When the participants arrived, they were asked to take part in two independent experiments: first, a recall task testing their memory, second, a product selection task. The participants were blind to the aims of both tasks. We manipulated stress using the same procedure used in Study 2. After the event recall task, participants were shown three pairs of products, each consisting of one "experience" and one "material good." Subsequently, they were instructed to indicate their preferences between the material good and experience. All participants were presented with the same material good (e.g., MUJI and Vacuum cup), while the experiential options were different. Some participants were presented with a low cognitive resource–demanding experiential option (e.g., Karaoke bar), whereas others were shown a high cognitive resource–demanding experiential option (e.g., Oil painting experience). In addition, as a manipulation check, we questioned participants to what extent they felt stressed (scores ranged from 1 = Not at all to 7 = Very much) and their perceptions of cognitive resource demands of the experiential options (1 = Very low, 7 = Very high). Finally, participants completed the demographic questions.

5.3. Results

5.3.1. Manipulation check

We initially tested whether the manipulation of stress and experiential options had been successful. The results revealed that participants who recalled stressful events reported significantly higher feelings of stress than those in the control condition [M_{stress} = 5.05, $M_{control}$ = 3.85, $t_{(207)}$ = 7.277, $p < 0.001$]. The results also revealed that high cognitive resource–demanding experiential options were perceived to have a higher demand for cognitive resources than low cognitive resource–demanding experiential options [$M_{high\ cognitive\ resource-demanding\ condition}$ = 4.01, $M_{low\ cognitive\ resource-demanding\ condition}$ = 2.21, $t_{(207)}$ = −10.928, $p < 0.001$], which, in turn, confirms that the manipulation of stress and experiential options were effective.

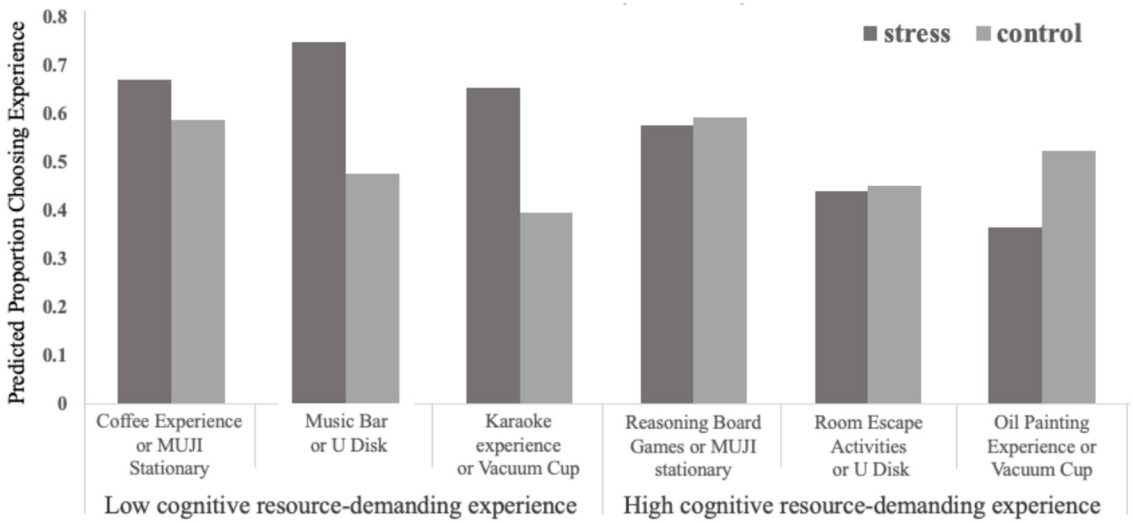

FIGURE 3
Proportion of participants choosing the experiential option, across five replicates, by condition (study 3).

5.3.2. Preference

Next, we summed the number of experiential products that each participant chose (for a possible score from 0 to 3) and coded this number as each participant's relative preference for experiential goods vs. material goods. A univariate analysis of general linear models revealed a significant interaction of stress and type of experiences on participants' preference [$F_{(1,205)} = 12.649$, $p < 0.001$]. In the low cognitive resource–demanding experiential condition, stressed participants demonstrated an increased preference for the experiential options compared to those who were not stressed [$M_{stress} = 2.08$, $M_{control} = 1.46$, $F_{(1,205)} = 16.18$, $p < 0.001$], thus replicating previous results. However, in the high cognitive resource–demanding experiential condition, there was no significant difference in the preference for experiential options between stressed participants and non-stressed participants [$M_{stress} = 1.39$, $M_{control} = 1.55$, $F_{(1,205)} = 1.45$, $p > 0.05$]. The results are shown in Figure 3.

5.4. Discussion

The results of study 3 showed that compared with experiences with low cognitive resource demands, the effect of stress on consumption preference for experiences disappears when such experiences have high demands for cognitive resources. Study 3 revealed an important boundary condition: participants with stress were more likely to prefer experiencing options only if those experiences helped them escape the psychological burden of stress. However, when experiences were complicated and cognitively demanding, the effect of stress on experiences disappeared.

6. General discussion

Across one survey and two experiments, we demonstrate the effect of stress on individuals' relative preference for experiential vs. material consumption and its psychological mechanism. Our studies show that stress increases consumers' preference for experiences over material goods. Motivation to escape from psychological burden mediates the effect of stress on consumers' preference for experiences. Specifically, stress as a self-threat triggers individuals' motivation to escape from negative self-concept, and experiences can help individuals temporarily escape from negative self-recognition and provide more leisure value than material possessions. Therefore, individuals increase their consumption preference for experiences. In addition, only the positive process of relaxation drives the effect of stress on consumer preference for experience. In this case, stressed consumers' increased preference for experiential consumption is reduced when experiential consumption is complicated and requires significant mental resources.

6.1. Theoretical contribution

This research provides references for the study of public mental health by exploring the relationship between stress and individuals' consumption preferences for experiences and material possessions. An important innovation of research is to connect stress with experiential and material consumption, Existing studies have predominantly focused on the effects of stress on individuals' psychology and physiology; however, there is limited information on how stress affects consumer behavior.

Consumption has become an important coping mechanism for stress and an avenue to enjoy leisure. Therefore, focusing on the relationship between stress and consumer behavior is necessary. Using self-escape theory, we have verified that stress increases individuals' consumption preferences for experiences over material possessions.

Our research also make theoretical contributions to research in the fields of psychology and consumer behavior. First, we provide direct empirical evidence that self-escape motivation can increase individuals' preference for experiences. Previous studies have determined that strong negative behaviors, such as suicide, binge eating, and gambling (21, 27), are common escape mechanisms. Furthermore, this study deduced that the consumption of experiences can also help individuals escape. This approach is more peaceful and positive and may improve individuals' ability to cope with difficulties. Therefore, experiential consumption is regarded as a happy escape, which helps us deepen the exploration of the escapism theory.

In the field of consumer behavior, enriching the research on antecedent variables of experiential and material consumption is also a major breakthrough in this study. Existing research has primarily focused on the difference and consequences of experiential and material consumption. However, our research introduces stress as the antecedent variable, explores its influence on individuals' consumption preferences for experiences and material goods, and explains the internal reasons of consumers' preferences for experiences and material possessions. Therefore, the exploration of individuals' consumption preferences for experiences in this research can be regarded as a supplement to related research.

6.2. Practical implications

Our conclusion provides recommendations for public mental health and stress management. Currently, emerging research is investigating interventions that could resist negative moods and facilitate the recovery from stressful situations. Importantly, non-pharmacological treatments such as enhancing exercise have been shown to be effective in treating symptoms of major depression (43). Our research suggests that experiential consumption can be considered as a relatively positive coping mechanism for stress with general interventions. As experiential purchases can generate and sustain happiness (44), consumers who are stressed can alleviate negative emotions and cope with stress through experiential purchases to obtain happiness.

In addition, our conclusions provide marketing advice for merchants in the experience industry. As stress increases individuals' consumption preferences for experiences, marketers of experiential products can locate target groups and undertake marketing plans accordingly. For example, travel products are increasingly favored by high-stress groups, such as office workers; therefore, for travel products, marketers can target these groups as customers. Moreover, marketers can strive to attract target groups by emphasizing the escapism effect of experiential products in advertisements and other marketing channels.

6.3. Research limitations and future research directions

This study has several limitations and issues that warrant future research. First, we adopted the general definitions of stress without differentiating between long-term vs. short-term stress (6). As long-term stress and short-term stress may have different effects, future research could further examine the types of stress to determine varying preferences on experiences vs. material possessions. In addition, there are many ways to measure stress, future research can adopt more diverse ways to measure stress, e.g., Patient Health Questionnaire 9 (45). Second, experiential consumption can be used as a coping mechanism for stress; however, whether this approach can effectively relieve stress and negative emotions remains unclear. Future research can examine consumers' stress and emotional differences before and after experiential consumption for further analysis. Finally, this study explores the effects of general experiential consumption. In fact, experiential consumption with different connotations (e.g., impulsive experiential consumption) deserves to be considered. Future study can pay attention to this and conduct in-depth research.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

YZ and XJ devised the project, the main conceptual ideas, and proof outline. XJ and TZ collected the research data and revised the manuscript. YZ and JL analyzed the sequencing data and wrote the initial manuscript.

All authors contributed to the article and approved the submitted version.

Funding

This research was funded by the National Natural Science Foundation of China (NSFC) (No. 71872070) and Youth Program National Science Foundation of China (No. 71902069).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 15 March 2023
DOI 10.3389/fpsyg.2023.1124025

OPEN ACCESS

EDITED BY
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SPECIALTY SECTION
This article was submitted to
Media Psychology,
a section of the journal
Frontiers in Psychology

RECEIVED 14 December 2022
ACCEPTED 07 February 2023
PUBLISHED 15 March 2023

CITATION
Gong Y, Chen C, Tan Y and Tang D (2023) How active social network site use affects green consumption: A moderated mediation model. *Front. Psychol.* 14:1124025. doi: 10.3389/fpsyg.2023.1124025

How active social network site use affects green consumption: A moderated mediation model

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A growing body of literature suggests a link between the usage of social networking sites (SNSs) and green consumption. However, researchers have shown that not all types of SNS usage have the same effect on individuals; therefore, to fully understand the relationship between a particular SNS use type and green consumption, as well as the mechanisms underlying the relationship, more research is required. This study examined a moderated mediation model based on self-awareness theory to explain the "how" and "why" of the relationship between active SNS use and green consumption. An offline survey (N=210) and an online survey (N=348) were conducted. The results suggest that active SNS use is positively associated with green consumption *via* public self-awareness and that impression management motives moderate the mediating role of public self-awareness in the relationship between active SNS use and green consumption. By examining the connection between a specific type of SNS use (active SNS use) and green consumption, our study adds to the body of literature on the causes of green consumption. The results have substantial implications for future research promoting socially responsible consumption behavior.

KEYWORDS

active SNS use, public self-awareness, green consumption, impression management motivation, self-awareness theory

Introduction

The consumption of environmentally friendly goods and services has become popular over the last decades and has been growing continuously (Ge et al., 2020; Kumar et al., 2021; Zhao et al., 2021). Green consumption, as a representative pro-environment behavior (Lee et al., 2014), is defined as the tendency to express environmental protection values through purchasing and consuming behaviors (Haws et al., 2014). Several studies demonstrated the benefits of green consumption for individuals, societies, and the environment (Li et al., 2022). Specifically, customers with green buy intent and behavior scored more highly on the life satisfaction scale (Xiao and Li, 2011; Dhandra, 2019). The degree of customer desire for green products is always positively correlated with overall societal welfare (Zhang et al., 2019). Moreover, green consumption helps solve the problems of the over-exploitation of natural resources (Nguyen et al., 2019) and controlling air pollution (Zhang et al., 2019). Therefore, it is essential to investigate the causes and the contributing factors of green consumption to induce consumers to go green (Fachrurazi et al., 2022).

In recent years, productive research has been conducted on the antecedents of green consumption, primarily personal attributes and external contexts. Personal attributes factors include self-construal (Mancha and Yoder, 2015), regulatory focus (Miniero et al., 2014), social

responsibility consciousness (He et al., 2016), and moral identity (Wu and Yang, 2018). In contrast, external contexts include message framing (Amatulli et al., 2019), social exclusion (Guo et al., 2020), and packaging color (Felix et al., 2021). Beyond these factors, SNS use has also recently begun to attract researchers' attention. Social media has become an important way for people to interact (Verduyn et al., 2020; Wang et al., 2020; Lau et al., 2022). As of 2021, there were more than 4.2 billion active social media users worldwide. By 2027, that number is projected to rise to 6 billion (Dixon, 2022). In turn, SNS use has had significant psychological and behavioral repercussions on individuals (e.g., Han et al., 2020; Pepper et al., 2022; Reed, 2023). Hence, more and more researchers have begun to explore the impact of SNS use on green consumption. For example, SNS use and online interpersonal influence were shown to be positively related to green purchase intentions among millennials in the United States (Bedard and Tolmie, 2018). SNS use was found to be associated with positive attitudes toward green cosmetics (Pop et al., 2020). More recently, SNS use was found could impact sustainable purchasing attitudes *via* the drive for environmental responsibility (Zafar et al., 2021).

However, previous studies have only explored the impact of general SNS use on green consumption. They have yet to consider the disparities across the various types of SNS use. Recent research on SNS use and its impact suggested that not all social networking activities are equally social and that there are significant differences in the effect of different SNS use types on people's attitudes and behaviors (Frison and Eggermont, 2016; Thorisdottir et al., 2019; Ng, 2020; Yue et al., 2022). These studies implied that when analyzing the effects of SNS use, we must focus on specific types of SNS use to draw valid conclusions (Frison and Eggermont, 2016; Verduyn et al., 2021).

Existing research classifies SNS use into two types: active SNS use and passive SNS use (Pagani et al., 2011). Active SNS use refers to the activities of exchanging information directly with other SNS users (Verduyn et al., 2017, 2021). Passive SNS use refers to simply consuming information posted by other people without directly communicating with them (Verduyn et al., 2017, 2021). Active SNS use could have positive consequences such as more social closeness (Neubaum and Krämer, 2015), higher social support (Frison and Eggermont, 2016), higher self-esteem (Lin et al., 2020), and higher subjective well-being (Verduyn et al., 2021). In contrast, passive SNS use leads to increased envy (Ding et al., 2017), increased loneliness (Burke et al., 2010), and more severe depression (Frison and Eggermont, 2016), which are antithetical to positive connections with others. Since green consumption is a positive altruistic behavior advocated by the public (Lu et al., 2013; Zhang et al., 2019), it is reasonable to construct the relationship between active SNS use (neither passive SNS use nor general SNS use) and green consumption. Unfortunately, as far as we know, there has yet to be an empirical study on the connections between active SNS use and green consumption. To address this research gap, we investigated the effect of active SNS use on green consumption and the explanatory mechanisms and boundary conditions involved.

Self-awareness theory (Duval and Wicklund, 1972) helps explain active SNS use and green consumption. Self-awareness theory suggests that the presence of an audience causes a person to calculate the difference between his or her current image and the expected image and to try to present the expected self (Leary and Kowalski, 1990; Carver and Scheier, 2001). When people frequently interact on SNS, their awareness of the audience's presence and public self-awareness could be enhanced (Froming et al., 1982; Tu and McIsaac, 2002). In response to this awareness, people may behave in ways that are more consistent with societal expectations (Duval and Wicklund, 1972; Carver and Scheier, 2001). As a pro-environment behavior, green consumption has been a consumer trend advocated by the public in the last decade (Lu et al., 2013; Zhang et al., 2019). As active SNS users become self-aware, they may be more inclined to engage in green consumption.

Therefore, the purposes of this study were to examine (a) whether active SNS use is linked to green consumption, (b) whether public self-awareness mediates the relationship between active SNS use and green consumption, and (c) whether impression management motivation moderates the relationship between active SNS use and green consumption. Thus, we established and tested a moderated mediation model (Figure 1). We used regression-based analyzes in two independent studies to test the hypothesized model. Our research contributes to the literature on SNS use and green consumption by examining the impact of specific type of SNS use (active SNS use). Meanwhile, this research has significant implications for governments' promotion on pro-environment behavior, companies' green consumption marketing efforts and for consumers to understand their consumption behavior.

Theoretical Framework and hypotheses

Self-awareness theory

We can draw on self-awareness theory (Duval and Wicklund, 1972) to build the conceptual framework of this research. When a person's attention is directed inward and triggered by the situation, it is called objective self-awareness (Yue et al., 2022). There are two kinds of self-awareness: public self-awareness and private self-awareness (Froming et al., 1982). These two types of self-awareness are susceptible to be impacted in distinct settings. For example, being recorded on video or having an audience can enhance public self-awareness, and looking in a mirror or keeping a diary can increase private self-awareness (Scheier and Carver, 1980; Froming et al., 1982). Behaviors that reflect personal attitudes may stem from a focus on the private self, while behaviors that reflect social expectations may stem from a focus on the public self (Froming et al., 1982). Researchers have used audiences to activate public self-awareness and make the individual's social attributes more prominent, thereby inducing regulatory behavior to match the audience's expectations (Scheier and Carver, 1980; Froming et al., 1982). When aware of an audience, the person compares themselves with the audience and if there is a discrepancy, they may actively change their behavior to be more congruent with the social standards (Duval and Wicklund, 1972; Carver and Scheier, 2001).

Previous studies confirmed the applicability of self-awareness theory in the context of social networking. Drawing on the theory of self-awareness, Marder et al. (2016) posited that the impact of SNS surveillance might make people feel monitored by audiences even in real life. Furthermore, Lavertu et al. (2020) found that the offline salience of online audiences will increase people's public self-awareness and external motivation, thus increasing people's willingness to participate in offline prosocial activities.

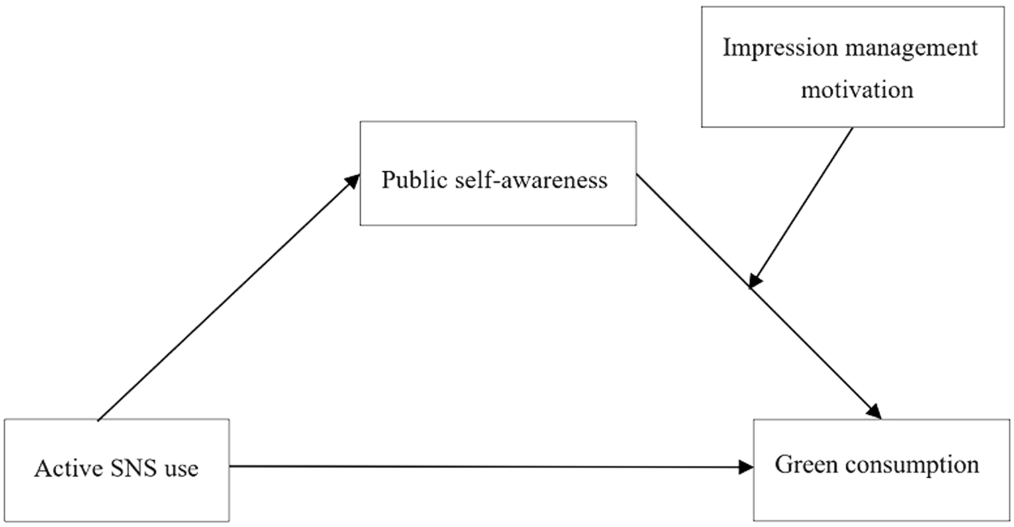

FIGURE 1
Overview of the proposed moderated mediation model.

Active SNS use and green consumption

Active SNS use involves sending messages, updating one's status, and posting photos in private or public channels (Frison and Eggermont, 2016). Active SNS use increases interpersonal interactions and communication and contributes to creating and developing relationships (Liu et al., 2020). Therefore, active SNS use will allow people to build more peer relationships than just passively browsing for information (Neubaum and Krämer, 2015; Thorisdottir et al., 2019). Compared to passive SNS use, which increases loneliness (Burke et al., 2010), active SNS use increases social support and attention from others (Frison and Eggermont, 2016). In addition, a previous study has pointed out that people who actively interact on SNS have the motivation to increase social capital (Burke et al., 2011), so they have a strong sense of audience when actively interacting on SNS. This is why consumers who actively share a zero-waste lifestyle (ZW lifestyle) on social media are able to adhere more to this lifestyle (SÄƒplÄƒcan and Márton, 2019).

Therefore, people will be aware of audience presence when interacting actively on SNS, and their sense of public self will increase accordingly (Tu and McIsaac, 2002). According to self-awareness theory, focusing on the public self may lead to behavior more aligned with social norms (Duval and Wicklund, 1972). Consequently, people who actively use SNS are more willing to conform to subjective norms than passive SNS users. Green consumption is an environmentally friendly behavior that the government and the public have advocated in recent years (Lu et al., 2013; Zhang et al., 2019), and it can help consumers develop caring and ethical social images (Griskevicius et al., 2010). Therefore, we hypothesize that people who are active SNS users will be more willing to engage in green consumption.

> *H1*: Active SNS use will be positively associated with green consumption.

The mediating role of public self-awareness

Public self-awareness may mediate the relationship between active SNS usage and green consumption. Public self-awareness is the degree to which individuals worry about what others think of them (Duval and Wicklund, 1972; Govern and Marsch, 2001). Therefore, when the perceived audience increases, people's public self-awareness will increase accordingly (Froming et al., 1982; Park et al., 2022). Conventional psychological researchers have used actual or perceived audiences to activate participants' public self-awareness (Scheier and Carver, 1980; Froming et al., 1982). Nowadays, SNS is a common way for people to communicate with a wide range of audiences (Cocea, 2017). Specifically, active SNS use, such as chatting with others or updating their status online, could enhance the perception of audience presence (Tu and McIsaac, 2002; Deters and Mehl, 2013; Ranzini and Hoek, 2017). Thus, active SNS use may be positively associated with public self-awareness.

The relationship between public self-awareness and green consumption has been well established. For instance, public self-awareness was shown to contribute to consumers' green restaurant consumption (Hwang and Lee, 2019). When consumers are publicly accountable, they are more responsive to other-benefit appeals and have higher purchase intentions for environmentally friendly consumption (Green and Peloza, 2014). According to self-awareness theory (Duval and Wicklund, 1972), individuals with high public self-awareness adjust their behaviors to meet the public's expectations. Green consumption is an altruistic behavior that conforms to social norms (Lu et al., 2013; Zhang et al., 2019), and active SNS users may engage in this behavior to reduce a discrepancy between self-awareness and public expectations.

In sum, active SNS use increases awareness of the audience's presence (Tu and McIsaac, 2002; Marder et al., 2016; Lavertu et al., 2020), creating a higher public self-awareness. In turn, higher public

self-awareness promotes behavior by public expectations (Froming et al., 1982), leading to more green consumption.

> *H2*: The relationship between active SNS use and green consumption will be mediated by public self-awareness.

The moderating role of impression management motivation

Active SNS use affects not everyone equally or to the same degree (Zheng et al., 2022). The relationship between public self-awareness and green consumption may vary from person to person. Not all people will make green purchases after active SNS use has stimulated public self-awareness, depending on whether they are motivated by impression management (Leary and Kowalski, 1990). Impression management involves impression motivation and impression construction (Leary and Kowalski, 1990). Impression management motivation is the desire to manage how one comes across to others (Goffman, 1959; Leary and Kowalski, 1990). Once people are motivated to create a certain impression, they are likely to perform certain actions to construct that image (Leary and Kowalski, 1990). For example, they may act in ways that are socially desirable to make a good impression (White and Peloza, 2009). Conversely, people with low impression management motivations will be less concerned about what others think of them. Accordingly, they are less likely to make efforts to improve the way others perceive them.

Research on impression management points out that people tend to make positive impressions of others, including the image that they possess solid prosocial attributes (Leary, 1986; Zhang et al., 2019). Meanwhile, green consumption can help consumers develop a social image of someone caring and ethical (Griskevicius et al., 2010). Like impression management theory, self-awareness theory suggests that when people are aware of an audience's presence, they may adjust their behavior to conform to social norms and expectations (Duval and Wicklund, 1972; Carver and Scheier, 2001). Thus, with increased heightened self-awareness, individuals with high impression management motivation may be more likely to engage in green consumption than those with low impression management motivation.

Thus, it can be assumed that impression management motivation can positively moderate the effect of public self-awareness on green consumption. Specifically, for people with high (vs. low) motivation for impression management, the self-awareness that comes from active SNS use has a stronger impact on green consumption.

> *H3*: The mediation effect of public self-awareness in the relationship between active SNS use and green consumption will be moderated by impression management motivation. Specifically, this mediation effect will be stronger for individuals with high (vs. low) impression management motivation.

Overview of studies

Two studies were conducted to investigate the hypothesized links. In Study 1, we conducted a preliminary survey study by paper-and-pencil questionnaires to test the proposed relationship between active SNS use and green consumption and the mediating role of public self-awareness. Study 2 was devised to replicate these results using online questionnaires and test the moderator of impression management motivation in the mediation role of public self-awareness. The two studies used different measures of active SNS use (two-dimensional or unidimensional) and green consumption (intentions or behaviors).

Active SNS use has been considered a two-dimensional construct in some research and a one-dimensional construct in others. As a two-dimensional construct, active SNS use includes both active public and private SNS use (Frison and Eggermont, 2016; Liu et al., 2020). Active public SNS use refers to the users' interactions with SNS friends in a public context (e.g., status updates and posting photos). Active private SNS use refers to private interactions between the user and SNS friends (e.g., sending private messages; instant messaging). However, researchers who support the idea of a one-dimensional construct question the public/private distinction in any cumulative self-reported measure and point out that privacy settings can vary across users, platforms, and posts (Erliksson et al., 2020). Thus, in Study 1, we used a two-dimensional scale to measure active SNS use, while in Study 2, we used a unidimensional scale. It is believed that the combination of two active SNS use scales can provide sufficient support for the findings.

Moreover, in addition to active SNS use, Study 1 and Study 2 also used different scales to measure green consumption. Previous studies have used either the green consumption intentions or behavior scale to measure green consumption (Lan and Sheng, 2014; Nguyen et al., 2019; Sun et al., 2019). One problem evident in the research on green consumption is the gap between attitudes and behaviors, meaning that green consumption values or intentions often could not translate into green consumption behaviors (Nguyen et al., 2019). Although intentions and behaviors are closely related, they are not precisely equivalent (Ajzen et al., 2018). Therefore, we used green consumption intentions and green consumption behaviors as dependent variables in two studies, respectively. Study 2 was meant to replicate and expand Study 1's findings from green consumption intentions to green consumption behaviors. Specifically, in study 1, we tested the relationship between active SNS use and green consumption intentions. In study 2, we tested the relationship between active SNS use and actual green consumption behaviors.

The scales used in these two studies have been shown to have good psychometric properties and have been widely used in previous studies. The English scales were translated into Chinese using the translation and back-translation method.

Study 1

Methods

Participants and procedure

The institution of the first author's research ethics committee approved the current work. Data were collected from Chinese consumers in shopping malls. Participants gave informed consent and were assured that the survey was anonymous. After reading an explanatory statement that briefly summarized the aim of the study, participants completed paper-and-pencil questionnaires. After the research, each participant received a modest token of appreciation for their time and effort.

We recruited 263 consumers to participate in the investigation using convenience sampling. The total sample consisted of 210 consumers who submitted valid responses, with a response rate of 79.85%. Of the 210 consumers (54.29% female) in the final sample, the majority of participants were between 18 and 24 years old (59.52%), followed by the 25–30 age group (25.24%). The majority of participants was pursuing or had a junior college or bachelor's degree (60%). Moreover, 68.57% of the participants earned below 50,000 RMB annually (about 7,169 U.S. Dollars), and 25.24% of the participants earned from 50,000 to 150,000 RMB annually (7,169 to 21,506 U.S. Dollars).

Measures

A measure of active SNS use developed by Frison and Eggermont (2016) was adapted for use in the current study. In the initial scale, the platform name "Facebook" was changed to WeChat, a social networking site that is more popular in China. Active public SNS use was assessed with three items such as, "How often do you post a message on your own WeChat Moments timeline?" Active private SNS use was assessed with two items, one of which was, "How often do you send someone a personal message on WeChat?" The ratings for each item ranged from 1 (never) to 7 (several times per day) on a 7-point Likert scale. The Cronbach's α was 0.96 and 0.84 for active public and private SNS use, respectively. The Cronbach's α of the overall active SNS use scale was 0.83.

Public self-awareness was measured by the revised Self-Awareness Scale (Govern and Marsch, 2001), including three items such as, "I am concerned about the way I present myself," "I am self-conscious about the way I look," and "I am concerned about what other people think of me." Participants were instructed to score each statement on a 7-point Likert scale, with 1 for "strongly disagree" and 7 for "strongly agree." In this study, Cronbach's α was 0.85.

A scale developed by Lee et al. (2014) was used to measure green consumption intentions. This six-item scale included items such as, "I am considering purchasing products that are less environmentally harmful" and "I am planning to purchase products that are made by an eco-friendly business." Participants were instructed to score each statement on a 7-point Likert scale, with 1 for "strongly disagree" and 7 for "strongly agree." In this study, Cronbach's α was 0.82.

Control variables include three variables. First, as women are more likely to be environmentally conscious and to scrutinize products advertised as sustainable compared with men (Kassinis et al., 2016), gender (0 = male and 1 = female) was controlled. Second, since education was found to be positively associated with green consumption (Sun et al., 2019), education level (1 = junior high school and below; 4 = master level and above) was controlled. Finally, personal annual income (1 = 50,000 RMB and below; 7 = 500,000 RMB and above) was also controlled because income was found to be positively associated with environmental perceived validity (Sun et al., 2019).

Analysis strategy

Study 1 used PROCESS macro (Hayes, 2013) in SPSS 24.0 to test hypotheses. SPSS PROCESS model 4 was used. 5,000 iterations of bootstraps generated the bootstrap-based 95% confidence intervals with bias correction for simple effects.

Results

Table 1 displays descriptive statistics and correlations among variables. The correlations among active SNS use, public self-awareness, and green consumption intentions were significant. These results offer preliminary support for H1 and H2.

Then, we did a confirmatory factor analysis to assess the discriminant validity of four self-reported measures. We compared two measurement models: the one-factor model and the hypothesized four-factor model. In the one-factor model, all of the items were loaded onto one factor. For the hypothesized four-factor model, items were loaded onto their respective hypothetical constructs. The results demonstrated that the fit index of the model was better when items were loaded onto their respective constructs (χ^2/df = 1.49, CFI = 0.98, TLI = 0.97, IFI = 0.98, RMSEA = 0.05) than when all items were loaded onto one factor (χ^2/df = 11.94, CFI = 0.50, TLI = 0.41, IFI = 0.51, RMSEA = 0.23). These results suggest that the measures in the model represented distinct constructs.

Table 2 (Equation 1) shows a positive relationship between active SNS use and green consumption intentions ($B = 0.33$, $p < 0.001$), H1 was supported. Both the total effect [effect = 0.33, 95% CI = (0.23, 0.43)] and the direct effect [effect = 0.27, 95% CI = (0.16, 0.37)] of active SNS use on green consumption intentions were positive and significant.

As for H2, the mediation effect of public self-awareness in the association between active SNS use and green consumption intentions was statistically significant [effect = 0.06, 95% CI = (0.02, 0.12)]. Specifically, as shown in Table 2, there was a significant and positive relationship between active SNS use and public self-awareness (Equations 2, $B = 0.45$, $p < 0.001$), as well as between public self-awareness and green consumption intentions (Equation 3, $B = 0.14$, $p < 0.01$). Thus, the mediation effect of public self-awareness was

TABLE 1 Means, standard deviations and correlations among study variables in Study 1.

Variables	*M*	SD	1	2	3	4	5	6
1. Gender	0.47	0.55	-					
2. Education level	3.18	0.69	0.11	-				
3. Income level	1.60	1.07	0.08	0.10	-			
4. Active SNS use	4.75	1.00	−0.07	0.06	0.16*	-		
5. Public self-awareness	4.91	1.20	0.01	0.06	0.02	0.37***	-	
6. Green consumption intentions	5.08	0.81	0.02	0.16*	0.07	0.41***	0.33***	-

$N = 210$; *$p < 0.05$, *** $p < 0.001$.

TABLE 2 Regression results of MODEL 4 in Study 1.

Variables	Equation 1 (Green consumption intentions)		Equation 2 (Public self-awareness)		Equation 3 (Green consumption intentions)	
	B	SE	*B*	SE	*B*	SE
Control variables						
Gender	0.05	0.09	0.09	0.14	0.03	0.09
Education level	0.15*	0.08	0.06	0.11	0.15*	0.07
Income level	−0.01	0.05	−0.05	0.07	−0.004	0.05
Independent variable						
Active SNS use	0.33***	0.05	0.45***	0.08	0.27***	0.06
Mediator						
Public self-awareness					0.14**	0.05
R^2	0.43***		0.38***		0.47***	

$N = 210$; *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

identified, supporting H2. Taken together, the results provided support for H1 and H2.

Study 2

Methods

Participants and procedure

Data for Study 2 were collected online using the Sojump website, which is one of the most popular online survey websites in China, similar to SurveyMonkey in America. The authors recruited a subset of participants by posting advertisements on their social networking accounts (e.g., WeChat, QQ, and Microblog) and by commissioning a professional questionnaire collection agency in China. After completing the questionnaire, participants were told that they would receive a small payment for participating (approximately $0.30 U.S. Dollars), and they could send the link to the questionnaire to their friends if they wanted. The research ethics committee at the institution of the first author authorized the current work. Participants gave informed consent and were assured that the survey was anonymous. The final valid sample comprised 348 consumers, resulting in a valid response rate of 75.32%. Of the 348 consumers, 52.30% were female. Most participants were between 18 and 24 years old (60.06%) and had a junior college or bachelor's degree (81.03%). Moreover, 42.53% of the participants earned below 50,000 RMB annually (about 7,169 U.S. Dollars), and 41.38% of the participants earned from 50,000 to 150,000 RMB annually (7,169 to 21,506 U.S. Dollars).

Measures

Whereas in Study 1 we measured active SNS use as two dimensions (public and private), in Study 2, we used a unidimensional measure named the Active SNS Use Questionnaire (ASUQ; Ding et al., 2017) to measure the frequency of active SNS use under various platforms (e.g., WeChat, QQ, Microblog) in the Chinese context (Lin et al., 2020). The measure consists of five items, such as: "I interact with friends when browsing their SNS (e.g., WeChat, QQ, Microblog) profile pages." Respondents rated on a 5-point Likert scale according to the frequency of each behavior occurrence, with 1 for "never" and 5 for "very often." In this study, the Cronbach's α was 0.83.

Public self-awareness was measured using the same scales used in Study 1. The Cronbach's α coefficient for public self-awareness in Study 2 was 0.72.

Study 2 used a different measure of green consumption than the measure used in Study 1. Specifically, the measure used in Study 2 assessed green consumption behaviors rather than green consumption intentions. The five-item scale (Kim and Choi, 2005) assessed the extent to which the participant purchased green products, as an indicator of actual green consumption behaviors. Example items are "I make a special effort to buy paper and plastic products that are made from recycled materials" and "I have avoided buying a product because it had potentially harmful environmental effects." Participants were asked to rate their agreement on a 5-point scale, with 1 for "never" and 5 for "very often." In this study, the Cronbach's α was 0.82.

Impression management motivation was assessed by a nine-item scale (White and Peloza, 2009). Example items are "I want to make a positive impression on others" and "I want to make myself look good to others." Participants were asked to rate their agreement on a 7-point Likert scale, with 1 for "strongly disagree" and 7 for "strongly agree." The Cronbach's α in the present study was 0.90.

The control variables were the same as those used in Study 1, namely gender, education level, and personal annual income.

Analysis strategy

Study 2 used PROCESS macro (Hayes, 2013) in SPSS 24.0 to test hypotheses. SPSS PROCESS model 4 and 14 were used. Five thousand iterations of bootstraps generated the bootstrap-based 95% confidence intervals with bias correction for simple effects. Aiming to replicate the findings of Study 1, study 2 used different measures of active SNS use and green consumption, and in addition tested the moderating role of impression management motivation.

Results

Table 3 displays the descriptive statistics and correlations for each variable in Study 2. All of the study variables had

TABLE 3 Means, standard deviations and correlations among study variables in Study 2.

Variables	*M*	SD	1	2	3	4	5	6	7
1. Gender	0.48	0.50	-						
2. Education level	3.07	0.46	−0.11*	-					
3. Income level	2.17	1.27	0.22***	−0.03	-				
4. Active SNS use	3.49	0.70	0.02	−0.03	0.12*	-			
5. Public self-awareness	5.75	0.81	−0.02	−0.01	0.10	0.46***	-		
6. Impression management motivation	5.87	0.72	−0.04	−0.003	0.14*	0.42***	0.75***	-	
7. Green consumption behaviors	3.85	0.63	−0.02	−0.05	0.18***	0.50***	0.55***	0.61***	-

$N = 348$; *$p < 0.05$, *** $p < 0.001$.

TABLE 4 Regression results of MODEL 4 and MODEL 14 in Study 2.

Variables	Equation 1 (Green consumption behaviors)		Equation 2 (Public self-awareness)		Equation 3 (Green consumption behaviors)	
	B	SE	*B*	SE	*B*	SE
Control variables						
Gender	−0.08	0.06	−0.07	0.08	−0.04	0.05
Education level	−0.05	0.06	−0.001	0.08	−0.05	0.05
Income level	0.07**	0.02	0.03	0.03	0.04	0.02
Independent variable						
Active SNS use	0.43***	0.04	0.52***	0.06	0.22***	0.04
Mediator						
Public self-awareness					0.11*	0.05
Moderator						
Impression management motivation					0.39***	0.05
Public self-awareness× Impression management motivation					0.10***	0.03
R^2	0.27***		0.21***		0.48***	

$N = 348$; *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

substantial relationships. These results preliminary supported our hypotheses.

Then, we ran a confirmatory factor analysis to assess the discriminant validity of four self-reported measures. We compared two measurement models: the one-factor model and the hypothesized four-factor model. In the one-factor model, all of the items were loaded onto one factor. For the hypothesized four-factor model, items were loaded onto their respective hypothetical constructs. The results demonstrated that the fit index of the model was better when items were loaded onto their respective constructs (χ^2/df = 2.57, CFI = 0.91, TLI = 0.90, IFI = 0.91, RMSEA = 0.07) than when all items were loaded onto one factor (χ^2/df = 5.42, CFI = 0.74, TLI = 0.71, IFI = 0.74, RMSEA = 0.11). These results suggest that the measures in the model represented distinct constructs.

Table 4 (Equation 1) demonstrates a positive relationship between active SNS use and green consuming patterns ($B = 0.43$, $p < 0.001$), H1 was supported. Both the total effect [effect = 0.43, 95% CI = (0.35, 0.51)] and the direct effect [effect = 0.27, 95% CI = (0.18, 0.35)] of active SNS use on green consumption behaviors were positive and significant.

As for H2, the mediation effect of public self-awareness was statistically significant in the association between active SNS use and green consumption behaviors [effect = 0.16, 95% CI = (0.12, 0.21)]. Specifically, as shown in Table 4, there was a significant and positive relationship between active SNS use and public self-awareness (Equations 2, $B = 0.52$, $p < 0.001$), as well as between public self-awareness and green consumption behaviors (Equation 3, $B = 0.11$, $p < 0.05$). Thus, the mediation effect of public self-awareness was identified, supporting H2.

As for H3, Table 4 (Equation 3) demonstrates a significant positive effect of impression management motivation on green consumption behaviors ($B = 0.39$, $p < 0.001$), as well as a significant positive interaction between public self-awareness and impression management motivation on green consumption behaviors ($B = 0.10$, $p < 0.001$). The moderating role of impression management motivation on the relationship between public

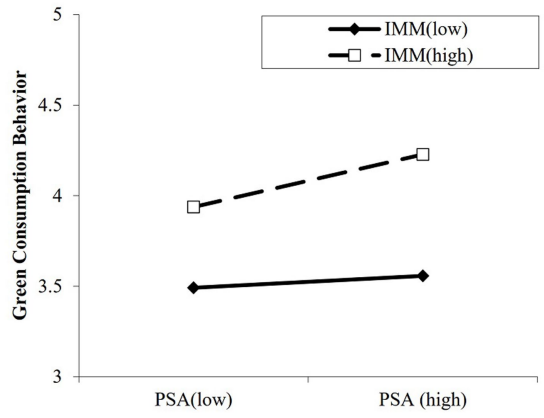

FIGURE 2
Moderating effect of impression management motivation on the relationship between public self-awareness and green consumption behaviors. PSA=public self-awareness; IMM=impression management motivation.

self-awareness and green consumption behaviors is depicted in Figure 2. Simple slopes tests demonstrated that the effect of public self-awareness on green consumption behaviors was significant for those with a high motivation for impression management [$B_{simple} = 0.18$, $p < 0.001$, 95% CI = (0.07, 0.28)], but not significant for people with low impression management motivation [$B_{simple} = 0.04$, $p = 0.42$, 95% CI = (−0.06, 0.14)]. Moreover, the mediation effect of public self-awareness was significant for people with high impression management motivation [effect = 0.09, 95% CI = (0.04, 0.15)], but not significant for people with low impression management motivation [effect = 0.02, 95% CI = (−0.03, 0.07)]. Taken together, the results support H3.

Discussion

This research found a positive association between active SNS use and green consumption. Previous studies have found that SNS use can influence people's pro-environmental behavior (Bedard and Tolmie, 2018; Pop et al., 2020; Zafar et al., 2021). Unlike previous studies, we focused on the relationship between a specific type of SNS use (active SNS use) and green consumption. By focusing on the connection between a specific type of SNS use (active SNS use) and green consumption, our study builds upon earlier researches while also expanding and deepening them. Our findings have important implications for governments, businesses, and individuals. Given that SNS has become an effective channel for promoting pro-environmental information (Chi, 2021), governments or companies can identify the target users for promotion or marketing by observing users' SNS usage types. On the other hand, for individuals, our findings provide explanations for how individuals' SNS use is connected with their green consumption. Besides, our study concluded that active SNS use motivates people to consume green, and those who consume green have been shown to have higher life satisfaction (Xiao and Li, 2011). Therefore, our finding enriches the literature on the positive outcomes of active SNS use by examining the impact of SNS on green consumption.

Second, our study found that public self-awareness was a mediating variable between active SNS use and green consumption. Previous studies have tested the role of SNS use on pro-environmental behavior by examining the effects of SNS use on promoting environmental responsibility (Zafar et al., 2021), altruistic and self-interested motivation (Pop et al., 2020), and perceived behavioral control (Nekmahmud et al., 2022). Unlike previous studies, our study tested public self-awareness as an explanatory mechanism for active SNS use and green consumption. Our findings are heuristically valuable to the study of self-awareness theory and provide a new perspective for understanding the relationship between SNS use and green consumption, helping to open the black box of the relationship between SNS use and pro-environmental behavior. For companies, marketers need to pay attention to the public self-awareness of social network users and try to motivate them to engage in pro-environmental purchasing behavior by using promotional tools that can stimulate their public self-awareness.

Finally, our study explored the moderating role of impression management motivation. Our study found that the effect of public self-awareness between active social network use and green consumption was significant only for individuals with high impression management motivation. As SNS has become a significant venue for self-presentation (Yang and Liu, 2017), previous studies have explored the antecedents and possible consequences of impression management on SNSs (e.g., Lee and Jang, 2019; Al-Shatti et al., 2022). This study extends the research on impression management in social networks by examining the moderating role of impression management motives in the relationship between public self-awareness motivated by active SNS use and green consumption. Governments or companies may post pro-environmental information on SNS platforms with low anonymity or strong social ties. These contexts may make users more concerned about impression management and more inclined to environmental protection (Marder et al., 2016; Lee and Jang, 2019). In addition, companies can design products with conspicuous pro-environmental symbols to encourage SNSs users to purchase.

Limitations and future research

Our research has some limitations. First, we considered only one moderator (i.e., impression management motivation) in the relationship between active SNS use to influence green consumption through public self-awareness. Recent researches have indicated that while examining the effects of SNS use on people's well-being or consumption behavior, the intensity of SNS use should be taken into consideration (Pellegrino et al., 2022; Valkenburg et al., 2022). Therefore, future research could consider the intensity of SNS use as a moderator of the relationship between active SNS use and public self-awareness. Such research could provide diverse suggestions for marketing practitioners to induce consumers to go green.

Second, this research found that public self-awareness mediated the relationship between active SNS use and green consumption. Recent studies suggested that social media use positively influences people's subjective norms (Nekmahmud et al., 2022), and subjective norms positively affect sustainable behavior (Roh et al., 2022). Therefore, future research could consider the mediation role of subjective norms in the relationship between active SNS use and green consumption. This research could help better understand the correlation between active

SNS use and green consumption and provide more theoretical guidance for consumers to understand their consumption behavior.

Third, the current study was conducted in China, and there may be questions about the universality of the results. Chinese collectivism encourages behavior that conforms to society. People are more likely to work together and help each other than their counterparts in individualistic western cultures, where people see themselves as independent entities, distant from their groups (Evanschitzky et al., 2014). As a person's public self-awareness and green intention could be affected by individualism–collectivism cultural orientations (e.g., Kim and Choi, 2005; Gu and Su, 2016), the results may not generalize to countries that differ culturally from China. Future researchers might look into the connections between active SNS use and green consumption in different cultures.

Conclusion

In the current research, we conducted two studies to examine the relationship between active SNS use and green consumption. It was found that active SNS use affects green consumption by increased public self-awareness, which is only significant for people with high impression management motivation. While most previous studies have focused on the relationship between general SNS use and pro-environmental behavior, our study takes a step forward by verifying the effect of a specific type of SNS use (active SNS use) on green consumption. Our study extends the research on the relationship between SNS use and pro-environmental behaviors and responds to the call of previous studies to refine the types of SNS use when examining its outcomes. In addition, this study extends the research on self-awareness theory and impression management theory. The results can provide guidance for governments and companies to develop more effective promotional and marketing strategies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Central South University Institutional Review Board. The participants provided their written informed consent to participate in this study.

Author contributions

YG contributed to conception and design of the study, assisted with the execution of the study and data collection, and provided critical revisions. CC and YT contributed to conception and design of the study, executed the study, analyzed the data, and drafted the manuscript. DT assisted with the data collection and drafted the manuscript. All authors contributed to the manuscript revision, read, and approved the submitted version.

Funding

The present research was supported by the Project of the National Natural Science Foundation of China (Grant No. 72072185).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 20 June 2023
DOI 10.3389/fpubh.2023.1175085

OPEN ACCESS

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RECEIVED 27 February 2023
ACCEPTED 24 May 2023
PUBLISHED 20 June 2023

CITATION
Yao Y, Gong WJ, Lai AYK, Wu YS, Sit SMM, Wang MP, Ho SY and Lam TH (2023) Associations of the perceived benefits and harms of COVID-19 with confidence in coping with the pandemic and mental health symptoms: a population-based survey in Hong Kong.
Front. Public Health 11:1175085.
doi: 10.3389/fpubh.2023.1175085

Associations of the perceived benefits and harms of COVID-19 with confidence in coping with the pandemic and mental health symptoms: a population-based survey in Hong Kong

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Introduction: Both perceived benefits and harms of COVID-19 have been reported, but whether they affect confidence in coping with the pandemic and mental health remains uncertain.

Objective: To examine the association of perceived benefits and harms of COVID-19 with confidence in coping with the pandemic and mental health symptoms.

Methods: A population-based survey was conducted on 7,535 Hong Kong adults from 22 February to 23 March 2021, when the 4th wave of COVID-19 was under control. Information on sociodemographic characteristics, perceived benefits (10 options) and harms (12 options) of COVID-19, confidence in coping with the pandemic (range 0–10), loneliness (range 0–4), anxiety (General Anxiety Disorders-2, range 0–6) and depression (Patient Health Questionnaire-2, range 0–6) was collected. Latent profile analysis was used to identify the combined patterns of perceived benefits and harms of COVID-19. The associations of combined patterns with confidence in coping with COVID-19, loneliness, anxiety, and depression were examined using linear regression (β coefficient) adjusting for sociodemographic characteristics.

Results: The combined patterns of perceived benefits and harms were classified into benefit (n=4,338, 59.3%), harm (n=995, 14.0%), and ambivalent (n=2,202, 26.7%) groups. Compared with the ambivalent group, the benefit group had a significantly higher level of confidence (adjusted β 0.46, 95% CI 0.33 to 0.58), and lower levels of loneliness (−0.35, −0.40 to-0.29), anxiety (−0.67, 0.76 to-0.59), and depression (−0.65, −0.73 to-0.57). The harm group had a significantly lower level of confidence (−0.35, −0.53 to-0.16), and higher levels of loneliness (0.38, 0.30 to 0.45), anxiety (0.84, 0.73 to 0.96), and depression (0.95, 0.84 to 1.07).

Conclusion: Perceived greater benefit from COVID-19 was associated with better mental health and stronger confidence in coping with the pandemic.

KEYWORDS

COVID-19, perceived benefit, perceived harm, confidence, coping, mental health

1. Introduction

The COVID-19 pandemic caused an unprecedented challenge to public health, including enormous loss of life worldwide and exacerbating psychological symptoms of anxiety, depression, and stress (1). Daily life had been severely affected by social restrictions, border controls, school closures, and stay-at-home orders (2). The unemployment rate reported by the Organization for Economic Cooperation and Development (OECD) rose by 3% and reached 8.8% at the onset of the outbreak, the highest rate in a decade (3). In contrast, potential benefits of the pandemic included increased hygiene literacy and stringent control measures, followed by plummeted global cold and flu cases (4, 5). Long-term work-from-home arrangements amid the pandemic also improved family relationships, communication, and emotional expression (6).

Individuals' positive and negative perceptions of the pandemic can coexist with independence (7). Three groups of perceived benefits and harms of COVID-19 were identified at the beginning of the outbreak (data as of May 2020): indifferent group (both low perceived benefits and harms), harm group (high perceived harms but low benefits) and benefit group (high perceived benefits but low harms) (8). However, perception toward COVID-19 could change over time, given that people could be protected against the severe COVID-19 outcomes owing to the vaccine availability (9, 10), as well as their emotional adaption to the changes in the way of life and work brought by the pandemic (11). Our later survey (conducted from February to March 2021) found that perceived benefits increased substantially over time, while perceived harms were lower and stable (12), suggesting the grouping patterns of perceived benefits and harms may be changed.

Mental health crisis were emerging worldwide with COVID-19 outbreaks (13). People with higher perceived harms (such as reduced social interaction due to social distancing and quarantine, and perceived risk of infections) were more likely to have mental health symptoms (14, 15). In contrast, people who perceived benefits of COVID-19 reported better well-being (16). The identification and acknowledgment of benefits from negative experiences enable better coping with these negative situations (17). Assessing the mental health and confidence in coping with the pandemic in different groups could help identify at-risk populations and develop tailored interventions to address and alleviate widespread mental health concerns and enhance public confidence to cope with the pandemic, but no related literature was found.

In the present study, we first identified the grouping patterns of perceived benefits and harms of COVID-19 using data collected from February to March 2021, and then assessed the confidence in coping with the pandemic and mental health symptoms (loneliness, anxiety, and depression) in different groups.

2. Theory and literature review

The meaning-making theory posits that when faced with a stressful event, individuals reappraise and make meaning to the situation, possibly leading to negative and positive reframing (18), also known as perceived benefits and harms. Perceived harms from the COVID-19 pandemic and corresponding containment measures were common and widespread, mainly including increased psychological disorders, reduced income, and increased family conflicts (16, 19). In recent years, plenty of studies in the field of positive psychology had focused on the personal and environmental resources that can be mobilized or developed to cope with stressful events (18, 20, 21). Among these resources, benefits finding is defined as the identification or perception of benefits from adversities (22). Both perception and active seeking of benefits from stressful events were identified as cognitive reappraisal strategies that promote personal well-being (23, 24). Benefits from the COVID-19 pandemic mainly includes personal and relational levels, such as improved personal hygiene, increased rest time, and better family relationship (8).

Although perceived harm and benefit appear to represent mutually exclusive extremes of reframing valence, the existence of a positive reaction to a negative event does not mean that the negative impact is thereby eliminated (21). The dual attitudes theory model also assumes that negative and positive evaluations of the same object can co-exist independently (7), in a manner that mutually overrides rather than substitutes for each other, which could generate four possible grouping patterns: high perceived benefits and harms (ambivalent group); high perceived benefits and low harms (benefit group); high perceived harms and low benefits (harm group), and low perceived benefits and harms (indifferent group). Using latent profile analysis, three groups (indifferent, benefit, and harm) of perceived benefits and harms of COVID-19 (8) had been identified at the beginning of the outbreak. Grouping patterns of perceived benefits and harms changed over time (12), so re-exploration of grouping patterns is warranted.

COVID-19 and containment measures caused unprecedented and remarkable economic and health concerns. People with higher perceived harms from negative situations are prone to have psychological disorders, while those with higher perceived benefits had been linked to optimal adaptation to stressful events (25). However, no studies have explored the associations of different perceptions of COVID-19, a long-term and widespread stressful event, with mental health symptoms and confidence in coping with the pandemic. In this paper, we aim to address the following questions:

> Q1: Have the pattern of perceived benefits and harms of COVID-19 changed as the outbreak progressed?
>
> Q2: What are the mental health status and confidence in coping with pandemic among people with different perceptions of COVID-19?

3. Materials and methods

3.1. Study design

Under the Hong Kong Jockey Club Smart Family-Link Project, we conducted the Family Amidst COVID-19 2 (FamCov-2) survey using a population-based combined sampling frame of landline telephone, mobile telephone, and online surveys on Hong Kong residents aged 18 and above ($n = 7,535$) from February 22 to March 23, 2021, when the fourth wave of the COVID-19 pandemic was under control in Hong Kong. We had three subsets of questions for FamCov-2 with each consisting of the core questions and the subset-specific questions to avoid burdening the respondents. About

one-third of the respondents randomly answered the subset-specific questions. Finally, 7,535 respondents provided data on perceived benefits and harms of COVID-19, mental health, and social demographic characteristics. Four thousand six hundred sixty-two respondents provided data on confidence in coping with the pandemic.

The study was carried out in accordance with the guidelines and regulations set out in the Declaration of Helsinki. Ethical approval was granted by the Institutional Review Board (IRB) of the University of Hong Kong Hospital Authority Hong Kong West Cluster (UW 20–651). Informed consent was obtained from all respondents before the survey.

3.2. Sampling methods

Detailed methods and procedures have been reported elsewhere (12, 26). Briefly, the landline and mobile telephone interviews were conducted by well-trained interviewers from Hong Kong Public Opinion Research Institute (HKPORI), a well-known local survey agency. All phone numbers were randomly drawn from a phone list that was generated by using known prefixes assigned to telecommunication service providers. Invalid numbers were deleted. Each telephone interview took around 10 min. For the landline telephone survey, only one eligible respondent (whose next birthday is nearest to the interview date) was selected in a household. Among 1,604 and 816 valid landline and mobile telephone samples, 1,022 (63.7%) and 500 (61.2%) respondents completed the interview, respectively. For the online survey, email invitations were sent by HKPORI to their probability and non-probability online panels. Of 4,311 and 44,514 probability and non-probability group members who opened the email, 641 (14.2%) and 5,372 (12.1%) respondents completed the survey, respectively.

3.3. Measurements

Perceived benefits of COVID-19 were asked by a question "what benefits have the COVID-19 outbreak brought to you?" with 10 options: improved general health; improved individual hygiene; decreased colds; decreased negative emotions; increased positive emotions; increased ability to cope with difficulties; improved efficiency of work/study at home; increased private time; increased rest time; increased knowledge of epidemic prevention. Perceived harms of COVID-19 were asked by a question "what harms have the COVID-19 outbreak brought to you?" with 12 options: increased physical pain; gained weight; decreased physical activities; worse sleep quality than before; increased mental distress; increased negative emotions; caused depression; caused anxiety; decreased efficiency of work/study from home; decreased private time; decreased rest time; delayed to see a doctor. Multiple options could be selected by respondents. There was no validated questionnaire on the perceived benefits and harms of COVID-19. The corresponding questions were designed by our team and have been published elsewhere (8, 12, 16). We had done some pilot tests, and no difficulties or sensitive issues were reported by pilot respondents, suggesting face validity.

Confidence in coping with the pandemic was assessed by a question "how much confidence do you have to deal with the COVID-19 pandemic." The question was rated from 0 (not confident at all) to 10 (very confident). Loneliness was assessed by a question "in the past 7 days, how long have you been lonely?" with 5 options: None of the time (0 points); 1 to 2 days (1 point); 3 to 4 days (2 points); 5 to 6 days (3 points); 7 days (4 points). The four-item Patient Health Questionnaire (PHQ-4) was used to assess anxiety and depression symptoms in the past 2 weeks, which consists of the two-item General Anxiety Disorder (GAD-2) and the two-item Patient Health Questionnaire (PHQ-2) (27, 28). GAD-2 measured social panic and anxiety disorders, two core criteria for generalized anxiety with a Likert-like scale ranging from 0 (not at all) to 3 (nearly every day). PHQ-2 covered two core diagnostic criteria for depressive disorder, depressed mood, and loss of interest, with the same scoring method. Both GAD-2 and PHQ-2 scores range from 0 to 6, with a score of 3 or above suggesting anxiety and depression symptoms (29, 30). We had validated the Chinese version of the PHQ-2 in Hong Kong (31). The internal consistency of GAD-2 and PHQ-2 were 0.81 and 0.76, respectively, in the present study.

Information on sociodemographic characteristics collected included: sex, age (18–24; 25–44; 45–64; ≥65 years), education attainment (secondary/below; tertiary/above), household monthly income (HK$ < 10,000; 10,000-39,999; ≥40,000; HK$7.8 = US$1), number of cohabitants (0; 1–3; ≥4) and housing type (rented; owned). Socioeconomic status (SES) was calculated as a composite score using the sum of education (secondary or below, postsecondary), household monthly income per person (lower, higher, compared with the Hong Kong median income), and housing type (rented, owned), and was categorized as low, middle and high.

3.4. Statistical analysis

All statistical analyzes were performed using Stata 15.1 (StataCorp LLC, College Station, TX, United States). All data were weighted by sex, age group, and educational attainment of the Hong Kong general population in 2019 (32) to improve the representativeness of the sample. Latent profile analysis (LPA) was used to identify the combined patterns of perceived benefits and harms. LPA is a person-centered classification method that divides individuals into different subgroups based on similar characteristics. To determine the optimal number of profiles, the following model fit indices were considered: (a) lower Akaike information criterion (AIC); (b) lower Bayesian information criterion (BIC); (c) a minimal observed subgroup proportion of 5.00% or more; (d) classification accuracy, in which higher entropy is preferred; and (e) a comparison between k and k-1 profile models using Lo–Mendel–Rubin likelihood ratio tests (LMR) and bootstrap likelihood ratio test (BLRT), with p value less than 0.05 indicating preferred K-1 model. After determining the number of profiles, respondents were assigned to the most likely profiles based on the highest posterior membership probability. Chi-squared test was used to examine the sociodemographic differences in the different groups identified. With the ambivalent subgroup as a reference, multivariate logistic regression yield adjusted risk ratio (RR) and 95%CI confidence interval (CI) of the groups of perceived benefits or harms for sociodemographic characteristics with mutual adjustment. Multiple linear regression was used to calculate the adjusted β coefficient to examine the associations of the identified groups with confidence in coping with the pandemic, loneliness, anxiety, and depression.

4. Results

Table 1 shows that after weighting, 52.2% were female, 38.6% were aged 45 to 64 years, 64.9% had secondary or below educational attainment, and 49.6% had a household monthly income of HK$10,000 to 39,999 (US$1 = HK$7.8). 75.8% lived with 1 to 3 cohabitants and 58.5% lived in their owned housing. 58.6% had lower income compared to the median income in Hong Kong, and 57.3% had lower socioeconomic status. 26.7% (2,202/7535), 59.3% (4,338/7535) and 14.0% (995/7535) of respondents were categorized as ambivalent, benefit and harm groups, respectively, quite similar to unweighted results (29.2%, 57.6%, and 13.2%, respectively).

4.1. Latent profile analysis model identification

The results for the statistical fit indices of the LPA models recommend three profile patterns, given the low AIC and BIC, high entropy, and a relatively equal proportion assignment (50%, 32%, and 18%; Table 2). According to the scores of perceived benefits and harms of COVID-19, we labeled the three profiles as (a) the ambivalent group, with respondents reporting high scores in both benefits (mean = 3.51) and harms (mean = 4.19); (b) the benefit group with high scores in benefits (mean = 3.38) and low scores in harms (mean = 1.33); (c) the harm group with low scores in benefits (mean = 1.09) and high scores in harms (mean = 6.56).

Table 3 shows that more females were in the ambivalent group (29.5% vs. 23.7%) and harm group (15.1% vs. 12.8%) than males ($p < 0.001$). More respondents aged 65 years or above were in the benefit group (71.3%), and more aged 25 to 44 years were in the harm group (18.1%, $p < 0.001$). More respondents living in rental housing (14.4%, $p = 0.02$) or of low SES (15.6%, $p = 0.02$) were in the harm group.

4.2. Associations of the different perceptions of COVID-19 with confidence in coping with pandemic and mental health symptoms

Table 4 shows that, in the adjusted model, male (RR 1.30, 95% CI 1.16 to 1.46, $p < 0.001$) and the older (65 years or older: 2.54, 1.91 to 3.39, $p < 0.001$) had higher RR of the benefits. Those aged 65 or older (0.61, 0.39 to 0.95, $p = 0.03$) and with higher household monthly income (≥ HK$ 40,000: 0.55, 0.38 to 0.79, $p = 0.001$; HK$ 10,000-39,999: 0.67, 0.49 to 0.90, $p = 0.01$) had lower RR of the harms.

Table 5 shows that the benefit group had a higher level of confidence in coping with the pandemic (β-coefficient 0.46, 95% CI 0.33 to 0.58, $p < 0.001$), and lower levels of loneliness (−0.35–0.40 to-0.29, $p < 0.001$), anxiety (−0.67, −0.76 to-0.59, $p < 0.001$), and depression symptoms (−0.65, −0.73 to-0.57, $p < 0.001$) adjusting for sociodemographic characteristics. The harm group had a lower level of confidence (−0.35, −0.53 to-0.16, $p < 0.001$), and higher levels of loneliness (0.38, 0.30 to 0.45, $p < 0.001$), anxiety (0.84, 0.73 to 0.96, $p < 0.001$), and depression symptoms (0.95, 0.84 to 1.07, $p < 0.001$).

TABLE 1 Characteristic of the survey sample (N=7,535).

	n	Unweighted (%)	Weighted[a] (%)
Sex			
Male	3,635	48.5	47.8
Female	3,861	51.5	52.2
Age (years)			
18–24	589	7.9	8.8
25–44	3,026	40.5	32.7
45–64	2,884	38.5	38.6
≥65	982	13.1	20.0
Educational attainment			
Secondary/below	2,103	28.3	64.9
Tertiary/above	5,340	71.8	35.19
Household monthly income (HK$, US$1 = HK$7.8)			
<10,000	751	11.7	14.79
10,000-39,999	2,458	38.2	49.6
≥40,000	3,231	50.2	35.7
Number of cohabitants			
0	684	9.1	8.4
1–3	5,772	76.6	75.8
≥4	1,079	14.3	15.9
Housing type			
Rented	2,886	38.8	41.5
Owned	4,562	61.3	58.5
Household monthly income[b]			
Low	2,857	44.4	58.6
High	3,583	55.6	41.4
Socioeconomic status (SES)[c]			
Low (1)	2,134	33.3	57.3
Medium (2)	2,181	34.0	27.9
High (3)	2097	32.7	14.8
Patterns of perceived benefits and harms[d]			
Ambivalent group	2,202	29.2	26.7
Benefit group	4,338	57.6	59.3
Harm group	995	13.2	14.0

Sample size varied due to missing data.
[a]Results were weighted by sex, age, and education of the Hong Kong general population in 2019.
[b]Household monthly income was compared to HK median income.
[c]Socioeconomic status (SES) was calculated as a composite score using the sum of educational attainment (0 = secondary or below, 1 = postsecondary), household monthly income per person (0 = lower, 1 = higher, compared with the Hong Kong median income), and housing type (0 = rented, 1 = owned), and was categorized as low (0–1), middle (2) and high (3).
[d]The patterns of perceived benefits and harms of COVID-19 used the three profiles model identified by latent profile analysis.

5. Discussion and conclusion

5.1. Principal findings

We found that respondents who perceived greater benefits from COVID-19 had better mental health and greater confidence in coping

TABLE 2 Results of statistical fit indices of latent profile analysis models (*N*=7,535).

Model	AIC[a]	BIC[a]	aBIC[a]	LMR_P[b]	BLRT_P[b]	Entropy[c]	Composition[d]
One profile	67387.56	67415.27					
Two profiles	66931.95	66980.44	66958.20	<0.001	<0.001	0.71	17%/83%
Three profiles	65655.34	65724.61	65692.84	<0.001	<0.001	0.77	50%/32%/18%
Four profiles	66593.91	66683.96	66642.65	1.00	1.00	0.75	11%/32%/44%/12%

[a]Smaller Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-adjusted Bayesian information criterion (aBIC) suggest better model fitness.
[b]Lo–Mendel–Rubin likelihood ratio tests (LMR) and bootstrap likelihood ratio test (BLRT) were used to compare the K and K-1 profile models, with $p < 0.05$ indicating the preferred K-1 model.
[c]Entropy was computed to determine the accuracy of profile classification, with higher values indicating a better separation between profiles.
[d]The composition represents the percentage of each subgroup, with a minimum observed group size of 5% or more indicating relatively equal group allocation.

with the pandemic, those who perceived greater harms had poorer mental health and lower confidence and were thus at greater risk. Our finding shows consistency with the insight that personal reappraisal of an event can generate both negative and positive reframing, as posited by meaning-making theory. Perceived negative impact of COVID-19 on lifestyle behaviors has been reported as a risk factor for mental health symptoms (33–35). Mental health symptoms, in turn, also led to various unhealthy behaviors (unhealthy eating habits, sleep disturbances, and increased substance use) (36–38), forming a vicious cycle. The potential risk of individuals perceiving great harm should be highlighted, and interventions are needed to facilitate their positive adjustment.

The three groups (ambivalent, benefit, and harm) identified by LPA, confirmed the independence of benefits and harms suggested by the dual attitude theoretical model. This pattern differed from those in our previous FamCov-1 survey (indifferent, benefit, and harm) (8), possibly reflecting the substantial increase in perceived benefits from COVID-19 and no large decrease in perceived harms from the FamCov-1 to the FamCov-2 survey (12). Through repeated outbreaks of COVID-19, people gradually adapted and built resilience to cope with stressful events, which explained the increased number of people who perceived benefits. Conversely, the threat of infection and continuing stringent control measures (quarantine, isolation, and restriction of cross-border travel) resulted in consistently high levels of perceived harms.

More females were found in the ambivalent group and harm group. Females were more prone to fear and perceived a greater threat from stressful events than males (39, 40). Females who were employed and worked from home amid the pandemic reported greater work–family conflict (41) and augmented burnout symptoms (42) than males. Some females such as housewives were less directly affected by job loss, working from home, and unpaid leave due to the pandemic. Unexpectedly, more respondents aged 45–65 and over 65, who might be more vulnerable and had more chronic diseases, were more likely to perceive the benefits of COVID-19, probably because they had more experience (such as the past experience during the SARS epidemic in Hong Kong in 2003) and knowledge to deal with difficulties and were better able to adapt to adversity. Respondents with higher monthly household incomes should have stronger financial support to cope with economic challenges from the pandemic and therefore perceived less harms from COVID-19.

Respondents in the harm group were less confident in coping with the pandemic. Since more respondents with low SES were in the harm group, they might have or perceive a greater economic threat amid the pandemic, and the increased uncertainty and fearful feeling may lead to lower confidence in coping with the pandemic. Confidence in coping might influence people's coping strategies. A previous survey in Taiwan found that having sufficient basic protective equipment, financial support, medical resources, and higher levels of social support were associated with higher levels of confidence in coping with the pandemic (43). Additional support and assistance for people in the harm group are needed to build their confidence in coping with difficulties amid the COVID-19 pandemic.

Consistent with previous studies reporting that the perceived impact of COVID-19 on daily life was associated with greater psychological consequences (44, 45), we found that respondents in the harm group showed more loneliness, anxiety and depressive symptoms. Concerns about current terrible situations and future negative consequences of COVID-19 could cause various mental and psychological symptoms (46, 47). A positive perspective can lead to positive emotions, adaption, and positive growth even in the face of threats and challenges (48). Cognitive reappraisal, an emotion regulation strategy in which people perceive stressful events as positive challenges rather than just negative threats (49), has been linked to decreased perceived anxiety and stress symptoms (50).

5.2. Implications

Positive psychological emotions are important to the psychological recovery process in individuals who experience intense stressors and mental disorders. Identifying and acknowledging the potential benefits of stressful events is linked to coping in a positive manner (22). It is suggested that while reporting the negative effects of the pandemic, governments and health agencies should advocate for the public to change their perspective and find potential benefits behind the negative effects of the pandemic.

Our findings highlight the need to identify and assist people in the harm group. Promoting positive emotions and adaptive coping skills can help minimize negative psychology. Educational or training program on cognitive reappraisal should be developed and delivered to the public (especially the harm group) to alter their negative appraisals, and build positive psychological resources to avoid psychological consequences.

5.3. Limitations

Our study had some limitations. First, causal inferences could not be drawn in this cross-sectional study. Second, recall bias might exist as all data were self-reported. However, collecting self-reported data from such a large sample using actual non-face-to-face way was

10.3389/fpubh.2023.1175085

TABLE 3 The patterns of perceived benefits and harms by weighted socioeconomic characteristics (*N*=7,535).

	Ambivalent n (weighted %)	Benefit *n* (weighted %)	Harm *n* (weighted %)	*P*
Sex				
Male	970 (23.7)	2,190 (63.5)	475 (12.8)	
Female	1,227 (29.5)	2,118 (55.4)	516 (15.1)	<0.001
Age (years)				
18–24	208 (36.4)	287 (47.0)	94 (16.6)	
25–44	1,003 (29.2)	1,531 (52.7)	492 (18.1)	
45–64	784 (26.2)	1759 (61.4)	341 (12.4)	
≥65	198 (19.5)	723 (71.3)	61 (9.2)	<0.001
Educational attainment				
Secondary/ below	531 (25.9)	1,334 (59.3)	238 (14.8)	
Tertiary/ above	1,647 (28.1)	2,951 (59.5)	742 (12.4)	0.07
Household monthly income (HK$, US$1 = HK$7.8)				
<10,000	175 (19.7)	479 (64.5)	97 (15.8)	
10,000-39,999	723 (26.5)	1,394 (58.0)	341 (15.5)	
≥40,000	975 (28.1)	1847 (61.2)	409 (10.7)	<0.001
Household monthly income compared to HK median income				
Low	801 (28.0)	1,661 (58.1)	395 (13.8)	
High	1,072 (29.9)	2059 (57.5)	452 (12.6)	0.15
Number of cohabitants				
0	186 (27.2)	412 (60.2)	86 (12.6)	
1–3	1,692 (29.3)	3,317 (57.5)	763 (13.2)	
≥4	324 (30.1)	609 (56.4)	146 (13.5)	0.08
Housing type				
Rented	866 (30.0)	1,605 (55.6)	415 (14.4)	
Owned	1,320 (28.9)	2,669 (58.5)	573 (12.6)	0.02
SES				
Low (0–1)	577 (24.9)	1,262 (59.5)	295 (15.6)	
Medium (2)	651 (27.7)	1,265 (60.7)	265 (11.6)	
High (3)	637 (27.1)	1,179 (61.7)	281 (11.2)	0.02

Sample size varied due to missing data.
Socioeconomic status (SES) was calculated as a composite score using the sum of educational attainment (0 = secondary or below, 1 = postsecondary), household monthly income per person (0 = lower, 1 = higher, compared with the Hong Kong median income), and housing type (0 = rented, 1 = owned), and was categorized as low (0–1), middle (2) and high (3).

practicable way amid the pandemic. Third, to minimize the length of the questionnaire and reduce the burden on the respondents, we did not collect more data on the intensity of perceived benefits and harms. Fourth, classification error might occur as respondents were assigned to specific profiles based on the posterior probabilities without knowledge of actual affiliation, but LPA is a robust and

TABLE 4 Adjusted risk ratios (RR) of perceived benefits and harms by demographic characteristics (*N*=7,535).

	Benefit vs. Ambivalent (Ref)		Harm vs. Ambivalent (Ref)	
	RR[a]	*P*	RR[a]	*P*
Sex				
Female	1		1	
Male	1.30 (1.16, 1.46)	<0.001	1.20 (1.02,1.42)	0.03
Age (years)				
18–24	1		1	
25–44	1.12 (0.90,1.40)	0.28	1.17 (0.86,1.58)	0.31
45–64	1.61 (1.28,2.02)	<0.001	0.97 (0.70,1.34)	0.86
≥65	2.54 (1.91,3.39)	<0.001	0.61 (0.39,0.95)	0.03
Educational attainment				
Secondary/ below	1		1	
Tertiary/above	0.85 (0.70,1.04)	0.12	0.89 (0.67,1.18)	0.41
Household monthly income (HK$, US$1 = HK$7.8)				
<10,000	1		1	
10,000-39,999	0.92 (0.74,1.14)	0.46	0.67 (0.49,0.90)	0.01
≥40,000	0.92 (0.71,1.19)	0.54	0.55 (0.38,0.79)	0.001
Number of cohabitants				
0	1		1	
1–3	1.09 (0.87,1.37)	0.45	1.40 (0.98,2.00)	0.07
≥4	1.12 (0.85,1.49)	0.42	1.45 (0.95,2.23)	0.09
Housing type				
Rented	1		1	
Owned	0.98 (0.82,1.18)	0.87	0.82 (0.63,1.08)	0.15
SES				
Low (0–1)	1		1	
Medium (2)	1.09 (0.87,1.36)	0.46	0.96 (0.70, 1.33)	0.82
High (3)	1.07 (0.76, 1.50)	0.71	1.26 (0.78,2.06)	0.35

[a]Sex, age, educational attainment, monthly household income, number of cohabitants, housing type and SES were mutually adjusted.

TABLE 5 Association of perceived benefits and harms of COVID-19 with confidence in coping with the pandemic, loneliness, anxiety and depression symptoms (*N*=4,662).

	Mean±SD	Crude β (95% CI)	*P*	Adjusted[a] β (95% CI)	*P*
Confidence in coping with pandemic (score 0–10)					
Ambivalent	6.59 ± 1.81	1		1	
Benefit	7.00 ± 1.77	0.44 (0.32, 0.55)	<0.001	0.46 (0.33, 0.58)	<0.001
Harm	6.27 ± 2.12	−0.37(−0.54, −0.20)	<0.001	−0.35(−0.53, −0.16)	<0.001
Loneliness (score 0–4)					
Ambivalent	0.91 ± 1.06	1		1	
Benefit	0.54 ± 0.82	−0.37(−0.42, −0.32)	<0.001	−0.35(−0.40, −0.29)	<0.001
Harm	1.36 ± 1.18	0.41 (0.33, 0.48)	<0.001	0.38 (0.30, 0.45)	<0.001
Anxiety (score 0–6)					
Ambivalent	4.01 ± 1.60	1		1	
Benefit	3.20 ± 1.33	−0.78(−0.86, −0.71)	<0.001	−0.67(−0.76, −0.59)	<0.001
Harm	4.88 ± 1.78	0.88 (0.76, 0.99)	<0.001	0.84 (0.73,0.96)	<0.001
Depression (score 0–6)					
Ambivalent	3.80 ± 1.52	1		1	
Benefit	3.04 ± 1.31	−0.76(−0.83, −0.68)	<0.001	−0.65(−0.73, −0.57)	<0.001
Harm	4.85 ± 1.77	0.97 (0.86, 1.08)	<0.001	0.95 (0.84, 1.07)	<0.001

[a]Adjusted for sex, age, educational attainment, monthly household income.

human-centered classification method. Finally, our results may not be generalizable to other populations due to differences in the severity of COVID-19, control measures, and socioeconomic contexts. However, the similar results in the proportions of the three groups with and without weighting (Table 1) and similar associations of the three groups with confidence in coping with the pandemic and mental health factors (Table 5) suggested that our results were not substantially affected by the demographic factors.

Data availability statement

The datasets presented in this article are not readily available because our analysis and paper writing on the results are in progress. Requests to access the datasets should be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board (IRB) of the University of Hong Kong Hospital Authority Hong Kong West Cluster (UW 20–651). The patients/participants provided their written informed consent to participate in this study.

Author contributions

MPW, THL, SYH, and WG: conceptualization. MPW, WG, and YY: methodology and formal analysis. YY: writing–original draft preparation. WG, AL, SS, MPW, SYH, and THL: writing–review and editing. WG and MPW: supervision. MPW: project administration. All authors have read and agreed to the published version of the manuscript.

Funding

This work was funded by the Hong Kong Jockey Club Charities Trust. The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Acknowledgments

The authors would like to thank the Hong Kong Public Opinion Research Institute for conducting the survey and all the respondents for their time.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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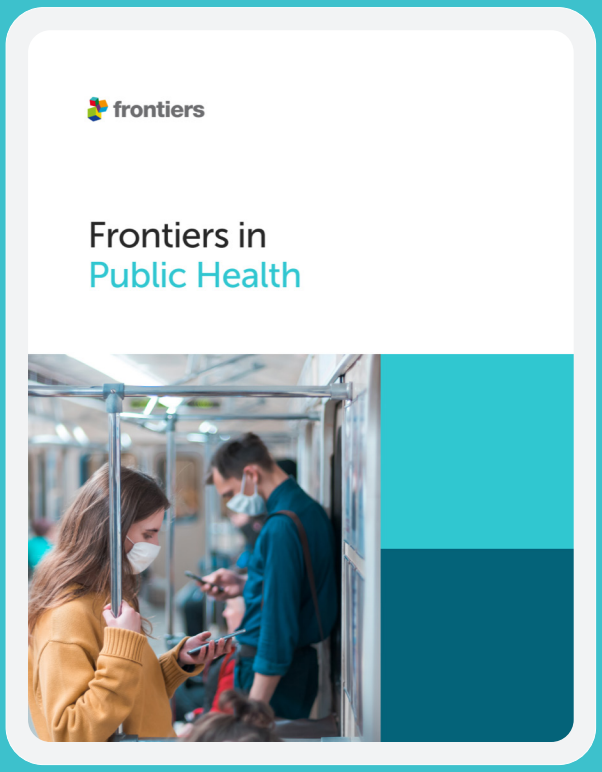

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