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Active Transportation, the Ultimate Low Carbon Way to Travel—A Review of International Research and Education

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Active transport[1] is a relatively new term but one that has been gaining support over the past decade as an alternative to "non-motorized transport" (NMT). Walking and cycling are the main transport modes within the active transport cluster. This paper summarizes the current state of international research and knowledge on active transport in urban and peri-urban areas in high-, middle- and low-income countries. It also explores current research gaps and potential "future looking" research areas. The information was collected in early 2020 and is based on a rapid literature review, a 15-question Internet survey, semi-structured interviews, and a peer-review process with key actors and experts in active transport. Respondents were professionally active in a broad range of areas directly or indirectly connected to the topic. A total of 112 cleaned responses[2] were obtained from high, middle- and low-income countries. The main findings show that there is a high level of scholarship in the subject, with a greater breadth of research in high income countries. There has been an increase in research attention since 1990. Both are widely covered by work on road safety aspects. A key difference can be seen between cycling and walking and their positioning as transport modes. More papers on cycling are published in transport-related journals, while walking is better covered in health-related journals. Based on the identified research gaps found in this review, suggestions are put forward for further possible research areas of interest on active transport in the post COVID recovery.

Keywords: active transport, active transportation, non-motorized/motorized, walking, cycling, road safety, health, vulnerable

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INTRODUCTION

The review summarizes the state of international research and knowledge on active transport in urban and peri-urban areas in high-, middle-, and low-income countries[3]. It also explores potential future looking thematic areas and research gaps that may accelerate police development and investment in these modes.

[1] The terms active transport and active transportation are interchangeable in this paper.
[2] 57 female and 55 male completed responses.
[3] Based on World Bank data.

Many cities are investing in transport infrastructure, especially in emerging economies, yet compared to motorized transport planning and practice, active transport receives less attention and there are known gaps in data collection, policy, and implementation (World Bank, 2019). Walking and cycling also receives less investment in dedicated infrastructure (ECF, 2019). This study looks to establish if these observations are due to a lack of research attention and/or publications on the topic. The review was undertaken to help identify gaps and propose entry points where research can be used to increase interest and investment in active transport modes as part of a shift toward more sustainable mobility and provide inputs to the development of inclusive urban transport.

APPROACH AND METHODOLOGY

Active transport is a relatively new term but one that has been gaining support over the past decade as an alternative to "non-motorized transport" (NMT). Active transport modes are used as primary modes and are also used to complement access and egress from motorized transport for people of all incomes and abilities.

Walking and cycling are the main transport modes within the active transport cluster and this paper summarizes the current state of international research and knowledge. The information was collected in early 2020 via a rapid[4] literature review of published academic and gray work and a 15-question Internet-based survey that collected opinions on the current state of research and implementation and views on how this is taught in transport education. This information was further explored with seven semi-structured interviews, and a peer-review process with key actors and experts in active transport.

LITERATURE REVIEW

The rapid review of published academic and gray literature on active transport was performed to establish the breadth of international study and to identify key research gaps. There are several bibliographic databases available online and these were used to identify peer-reviewed articles and gray literature published by recognized IGOs, NGOs, and/or government agencies. In contrast to a conventional bibliometric literature review, it did not look to answer a specific research question but to indicate the state of knowledge and explore the breadth of published works on the topic in general. Attempts made to find relevant literature published in other languages (such as French, Spanish, or other languages relevant to non-English-speaking geographies) proved to be difficult and time consuming. After an initial search, English was chosen as most transport journals publish in English. It is not thought that this has given any negative bias to the results.

The literature search was undertaken between March and May 2020, using public internet search engines (such as Google Scholar), the Transportation Research International Documentation database (TRID) – one of the largest online bibliographic databases of transportation research, Science Direct and a selection of key peer-reviewed journals (Elsevier, Sage, and Oxford Academic). It was felt that this would cover most publications. The following keywords were used (inter alia) with both UK and US English spelling urban, non-motorized/motorized, active transport/travel/ transportation, walking, pedestrian, cycling, biking, and combinations such as walking plus children/seniors/women/vulnerable. Despite the large number of key words used for the searches, several known papers did not show up. This is because none of main key words featured in the title, abstract or keywords and is a recognized limitation of a keyword-based search strategy.

SURVEY METHODOLOGY

To build on the findings from the literature searches selected respondents were invited to take part in the internet survey by direct invitation. The recipients of the direct email invitations were sourced from an initial review to identify key players, existing networks, and professional groupings, complemented by the researchers' networks and suggestions, and recommendations from several independent sources. The final list included practitioners, researchers, and other active transport experts. Contacts were drawn from high-, middle- and low-income countries to see if there were any differences between the respondents' answers in the different regions. Efforts were also made to include the views of different communities of interest and profiles beyond research, including active transport advocates and practitioners, NGOs, and the public and private sectors. The key findings from the literature review were used to develop the internet questionnaire.

As the review also investigated if there were any differences in active transport research between the Global North and South, care was taken to ensure that there was geographical balance in the invitations as well as a gender (male/female) balance. This allowed the perspectives of the Global North and South to be collected and to capture information from those whose mother tongue was not English (as only key words in English were used for the literature search). This is considered to be an innovative contribution to the active transport evidence base.

The survey questions were developed from the initial findings of the literature search and included both single and multiple answer questions. Most of the questions allowed respondents to add individual comments[5]. The survey links were circulated to over 100 international email addresses and it was also promoted to a wider audience via Twitter and Linked-In. A total of 132 responses were received (including those that replied to the personal invitation and those that responded spontaneously via the platforms used for promotion) resulting in 112 cleaned[6] responses.

[4]Rapid reviews are a form of evidence synthesis that may provide more timely information for decision making compared with standard systematic reviews https://guides.temple.edu/systematicreviews.

[5]A large number of comments were received which were included in the analysis.

[6]Cleaned means that the responses were checked for completeness and only those that were finished included in the analysis.

No definition was provided for active transport in the survey; however, suggestions were made in some questions (especially those on walking, cycling, and micro mobility). Possible research gaps were ranked and prioritized by the respondents, and these findings were further discussed in the interviews.

KEY INFORMANT INTERVIEWS

Seven semi-structured key informant interviews were made with a selected group of researchers, practitioners, and academics. They were chosen based on the number of times their name had been mentioned in the process of constructing the original list of email invitations and their availability. The interviews followed a topic guide based on the initial findings from the survey. Four further, but less formal, interviews were also undertaken and documented. This was undertaken to avoid bias and to validate the main findings and research gaps. The information collected was used to identify and explore any differences between the regions and to investigate the research needs and gaps more deeply. The key discussion points from the interviews have been included in the findings.

PEER REVIEW OF DRAFT REPORT

A further three reviewers from Global North and South were invited to comment on initial drafts of the report. They were chosen to represent both academic research and practitioners' perspectives. Their comments were incorporated into the final report and this paper. Furthermore, the final list of possible research areas was validated by a wider reference group composed from the list of invited and spontaneous respondents. The initial findings were also presented at two international workshops, and any further comments have been incorporated into this paper.

MAIN FINDINGS FROM THE LITERATURE REVIEW

The results indicate that there is an extensive volume of publications on active transport. Indeed, several thousand references were found with the combined use of all the keywords. Publications addressed various different aspects of active transport[7], non-motorized transport (including the UK and US spelling of motorized), walking, cycling (pedal, assisted and electric bikes), bike sharing, road safety, vulnerable road users and micro mobility. Public transport in urban contexts (when accessed by these modes) was also included. Road safety featured highly as a topic for both walking, cycling, and combined papers.

Thus, there is a large body of research available. Several searches are shown in **Table 1** using combinations of key words covering specific aspects associated with these modes, especially filtering published work with the words 'urban, active transport and active transportation'. It should be noted that the term non-motorized transport is only used in transport publications, while active transport is also used as a medical term; and these results may include these references.

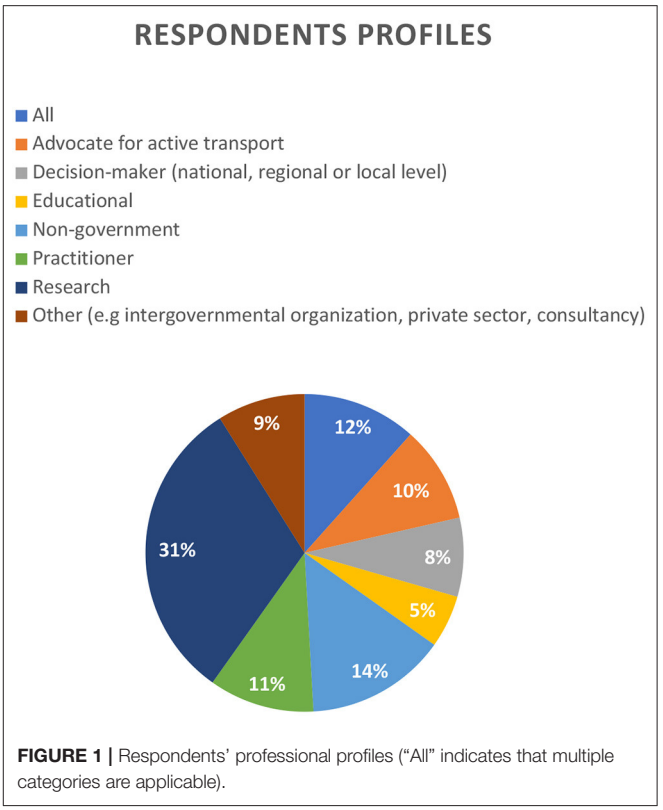

FIGURE 1 | Respondents' professional profiles ("All" indicates that multiple categories are applicable).

This does not alter the fact that there is a large number of publications referring to active transport. More than 3,630,000 publications were found in Google Scholar using the key words "active transportation[8]," with 1,930,000 of these being published between 2000 and 2015. Science Direct also located more than a million publications in the same time period. Looking at the past five years 11,700 records of publications were found in the TRID database using the keywords "active transportation." Papers were also found in the many journals that publish research on cities, sustainable development, urban planning, safety, health, and physical activity. These findings only highlight that the subject of active transport has been on research agendas for many years.

There has been an increase in the total number of publications since 2000. Science Direct identified 700 papers published in 1999 and 12,500 in 2021 (using the same key words: active transportation, physical activity), indicating a strong growth in studying this subject. Results using other filters are shown in **Table 1**.

The most researched topic combined active transport with road safety, followed by health (the positive physical benefits are

[7]It should be noted that the results of using this phrase were hampered by it being widely used in medical terminology, resulting in a large number of non-transport related papers being referenced in the internet search.

[8]Excluding medical papers that also use the term 'active transport'.

TABLE 1 | Overview of literature-review results 2001–20.

Keywords used	# hits google scholar	# hits science direct	# hits TRID
Cycling, urban	283,000	137,950	3,615
Walking, pedestrian, urban	83,500	7,775	2,126
Seniors active transport	20,100	19,100	633
Women, vulnerable, active transport	166,000	13,500	5,875 (+ road safety without vulnerable)
Children vulnerable, active transport	179,000	15,100	4,480 (idem)
Road safety, vulnerable users	112,000	10,448	15,000 (without vulnerable)

more studied than mental aspects)[9]. The highest number of hits (for the period 2000–20) was obtained using the keywords road safety and vulnerable road users. Thus, we concluded that many research papers focus on the negative safety aspects of the active modes within traveling environments (Wittink, 2001).

Examples from the Global North indicated that walking and cycling are more often "modes of choice" for those living in high-income countries. On the other hand, many people walk out of necessity, rather than choice, in low-income countries; and walking distances of 5–15 km daily are not unusual. This indicates that in these regions walking is a means of transport in both urban and rural contexts, which does not appear to be the case in the case in higher income regions.

A few special editions of transport journals are dedicated to either walking, cycling or both (such as Taylor Francis Transport Reviews, Volume 40, 2020 and Volume 36, 2015). Both modes also feature strongly in international publications (which may cover them in terms of transport and/ or combined with health), such as those by the World Health Organization (WHO) which has published guidance on physical activity highlighting the health benefits of walking and cycling (WHO/Europe, 2019).

Apart from major transport and health journals, conference publications, reports and guidance were included in the review. Examples include the annual Velo City (since 2013) and Walk21 (since 2000) conferences. Both make a call for papers on an annual basis, often receiving more than 1000 paper submissions[10] each.

The review identified that there are more technical papers published on cycling in transport (and related) journals than walking, while walking was better covered in health or combined topic journals (see **Table 1**). Compared to cycling, walking was found to be given less attention in transport research, with fewer papers published in transport journals. On the other hand, it is well-covered in health and other journals (especially as a lifestyle choice or part of road safety investigations). Examples of journals include Health Promotion International and Transport and Health.

A single modal focus was also observed in most research papers, with fewer studying cross-disciplinary or combined aspects within transport. Some looked at non-modal-specific aspects of active transport (poverty reduction, equity, climate change, etc.). A rapid review of a selection of papers of combined aspects associated with active transport, identified with a combination of key words and active transport, showed that much of the published research tends to be context specific and not scalable (i.e., the scope was limited to a town or city, or smaller areas within these).

The search also highlighted the large number of dedicated forums (both domestic and international) where these modes are discussed, and knowledge is generated. A scan of policy documents, toolkits, and reports using the key words combined with the names of organizations including European Commission, World Bank (and other international development and funding agencies), United Nations agencies, governments, forums and networks such as C40 (a network of the world's megacities committed to addressing climate change), The Institute for Transportation and Development Policy (ITDP), and private players such as private sector companies (e.g., ARUP and Rambol), showed numerous tools, policy guidance, toolkits and reports, as well as a growing number of audit tools and apps.

Many papers and reports highlight that there are differences between walking and cycling. Despite this being recognized in the literature, most documents on implementation and policy usually bundle these modes together. For example, policy documents frequently mention walking as being "of importance," but cycling is given more attention in the supporting text. The recent publication by the UK Department of (UK Department for Transport, 2020)—A gear change for cycling and walking—provides an example (UK Government Department for Transport, 2020). Walking is mentioned in all three main sections, including the one on guidance, based on the contents page, but almost all attention in the text is on cycling, with few references made to walking. Thus, it appears that cycling gets the lion's share of attention for strategies and investments.

Cycling is more widely documented as a transport mode, especially in the urban context, compared to walking. We also found that more publications advocated cycling, rather than walking, as a transport mode. However, neither are perceived as desirable transport modes (especially not in urban areas) due to road safety concerns, highlighted by the large number of papers on the negative aspects of interactions between active and motorized modes.

There are also more examples of stand-alone strategies for cycling than for walking. Additionally, it was noted that

[9]Investigating the mental health benefits of active transport is more developed in the health domain than in transport. The recent pandemic has highlighted the need to non-medical interventions to help address mental health issue indicating a possible avenue of cross discipline research interest.

[10]No filter was made to see if these have been published or not.

numerous policy documents focus predominately on local interventions, with only a few addressing regional or national issues. Local actions and policies for promoting cycling and/or walking are widespread, but there are perceptible gaps in policy documentation at higher, strategic levels. There are also fewer regional or national strategies for walking than for cycling. Some examples were found, such as (Let's get Scotland walking, 2014; Rotterdam Walk Project Team, 2020). Regional examples can be found especially from North America. California stands out from other states and has a history of both separate and combined plans for pedestrians and cycling, although some Active Transportation Master Plans have now been adopted at county jurisdictional and individual city levels elsewhere.

Furthermore, similar to many of the research papers, most of the platforms and forums identified tend to address *either* walking *or* cycling. Some combined either mode with one other aspect (such as road safety or health), but few looked to support active transport as a cluster. Cycle tourism, especially covering increasingly larger regional multi-country zones, is also quite widely studied as a separate issue, but this was considered to be outside the scope of this review. These works predominantly focus on Europe or North America. Long-distance walking for leisure or tourism was also not directly analyzed in this study.

Nonetheless, there has been a noticeable increase in all categories of publications (academic, policy and implementation levels) concerning active transport over the past 5 years. The majority being published in the Global North (Europe or North America) but a growing number were found from Latin America (especially Colombia and Mexico) and this appears to be increasing year on year. Sub-Saharan Africa appeared to have the least (especially in respect to urban areas). While active modes are now mentioned more often in national/regional sustainable transport strategies[11] and master plans, few have identified measures, actions and funding that specifically encourage their development or provide financial support to all active transport modes (combined).

Few authors stand out in regional or multi-country contexts. Many of the authors cited focused on either walking or cycling rather than covering active transport thematically. No significant difference was observed in the number of female or male researchers publishing. However, this may warrant further investigation, as interviewees commented that generally young female researchers are often given fewer opportunities than males (this was mentioned more often in reference to the Global South).

A key finding from this review is the high level of academic scholarship in active transport and the numbers of guidelines, reports and tools that are available from non-academic sources indicating that there is a broad body of evidence available.

[11] With the support from agencies and NGOs such as UNEP, IDTP, several African cities have now NMT/Walking strategies. This is a relatively new development. An African network for researchers and practitioners has also been (Rotterdam Walk Project Team, 2020). Research will be needed to keep these programmes going and the local politicians need also to remain motivated beyond the life of the project.

SURVEY RESULTS

A total of 112 cleaned responses were obtained from the survey with respondents from high-, middle- and low-income countries, as well as from those who brought generalized international perspectives (see **Figure 1**)[12]. A cleaned response is a survey report that has been checked for completeness, with those that were incomplete, inaccurate, or had been corrupted for any reason removed. Most respondents were professionally active in a broad range of areas (including academia), directly or indirectly connected to the topic, with around a third working on more than one aspect (indicated as all in **Figure 1**). Many were involved in local, rather than national, passenger transport with a few representatives from urban freight deliveries. The survey allowed respondents to make comments and those of particular interest were noted and discussed in the interviews.

No definition of active transport was provided and many of the responses spontaneously focused on passenger transport. Nonetheless, local urban freight deliveries were also mentioned especially in some of the answers to the survey questions.

Most survey respondents felt that they understood the term "active transport." From the 110 responses to this question, 58% answered that they understood the term very well, 23.5% quite well, 13% felt that they had a general understanding. Only 5.5% responded that they did not understand the term well and a single respondent indicated having heard the term being used but did not really understand what it meant.

There was unanimous consensus that walking and cycling form the backbone of active transport modes. Walking received slightly fewer votes than cycling (not assisted), and this may be because walking is not broadly recognized as a mode of transport. Respondents also indicated that public transport should be included (as the access and egress from it required at least one active mode) but not everyone agreed on this. There was also some level of support for including newer modes, such as kick scooters and skateboards. But there is still disagreement on whether the new alternative modes that may include small intermediate, and electric powered vehicles should be considered as active transport modes. Additionally, from the comments, hand carts and cycle rickshaws were suggested as additions to be included as active transportation as they are of particular importance in some countries in the developing world.

KEY FINDINGS FROM THE LITERATURE REVIEW AND SURVEY RESULTS COMBINED

Increased Attention From Research Communities

Survey respondents agreed that walking and cycling has received more research attention over the past decade and there has been an increase in investigating different aspects of both cycling and walking. However, many also noted that despite this there was

[12] 57 female and 55 male responses.

still a lack of investment and infrastructure on the ground. This was highlighted in the survey comments and interviews.

Based on the survey responses, interest in the active modes is more developed and more mature in higher-income countries (HICs). This is reflected in a more nuanced set of identified research gaps and needs. Tools and data collection were rated highly everywhere, and this was also highlighted in many of the interviews. Additionally, there was also a high level of interest in research on equity and gender aspects of active transport. The author suggests that this may be a result of attention to the gendered impacts of COVID-19 and the pandemic's impact on public transport, combined with a more generalized increased interest in inclusive transport and gender issues at national and local levels. This increased interest in equity and gender was confirmed with the increase in the number of published papers, policy documents, and tools found in the literature review for the past 2 years.

Research and Geographical Differences

The study showed up some clear differences in active transport research interest areas between the geographical regions. For the purpose of this study, the Global North represents higher income countries and the Global South mid and lower incomes countries. Based on comments in the survey and interviews, and the few papers published on this topic from middle-income countries, the author decided that there were not enough differences to consider them separately.

The survey results suggested that research efforts on active transport in the Global North was relatively well-developed, with many examples of collaborative studies (for example between European countries and covering a wider range of topics). Conversely studies coming from the Global South appear highly fragmented, with much of the research focusing on the problems facing those who use active transport (road safety and poor infrastructure featuring highly). Few respondents or interviewees highlighted good practices, with some Latin American countries being exceptions[13]. Furthermore, there is also little evidence of South/South exchanges of experience or case studies, especially any including robust evaluations and documenting the learning from projects and initiatives.

As indicated in the literature review, many papers investigate local conditions and contexts, making the findings difficult to replicate or scale. Generally it was observed that while the intersection of active transport with other modes is quite well covered, intersections with other subjects—such as economic and social aspects, or quality of urban life—are not. There are also notable gaps in multi-, trans- discipline and multi-criteria studies of active transport[14].

[13]Such as the success of the Cyclovia concept. Cyclovia is the Spanish word for bicycle path and is now used to describe a temporary or permanent cycling event with priority bike paths connecting car-free parts of a town or city. The first Cyclovia took place in Bogota in 1976 where it is now enshrined in law.

[14]Trans discipline was added here. Transdisciplinary Research is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem.

Thematic Areas of Interest

The survey respondents identified a number of common thematic areas of interest and perceived research gaps for future research. The topics were ranked and prioritized by the survey respondents and these findings further discussed in the interviews. There were few regional differences in the thematic areas that were consistently selected as priority areas for future research, but there were slight variations in their ranking. Thus, the list presented below reflects the topic areas for future research based on the responses from the survey:

- Equity and active transport - including gender, age, children and people living with disabilities.
- Recognizing walking as a transport mode.
- Data collection and tools.
- The economic benefits of walking and cycling.
- Safety and security (featured in top three in LIC).
- Walkability (pedestrian and cycling infrastructures).
- Governance and policy.
- Changing behavior (more highly ranked in HIC).

Data collection was particularly highlighted in the interviews as a key need (all regions). The topics of equity, gender and active transport were separate questions in the survey, but from the analysis the responses were similar so they could be bundled together under one title. This topic was ranked the highest for all regions[15].

Overall, there was a greater focus on pedestrians rather than cyclists by those from LICs and MICs. Despite walking being quite well covered in the literature, from the comments received in the survey it was not felt that this evidence positioned it a transport mode. Research on the intersections of safety and security were ranked particularly highly for LICs. Interactions between active transport modes and public transport, aspects regarding an aging population and urban freight had good support from those in HICs but was only ranked sixteenth (low) out of twenty-one in LICs.

Thus, recognizing walking as a transport mode was found to be an area for future research for all regions. It was consistently mentioned in the survey responses, comments and interviews and ranked second for LICs and third for HICs. The literature review also found papers supporting the concept of walking as a means of transport did not feature strongly in transport research.

Support for improved evidence on walking as a transport mode was closely followed by the need for better data and tools (including measures and standards), and then governance and economic aspects. Social aspects (including equity, gender) and economic aspects were also identified as critical thematic areas in all regions, also indicating research gaps.

Differences in the ranking of the topics provide some insights into regional and national interest levels. For example, safety, and security was ranked higher in the Global South, while environmental aspects, were less of a concern. This was found to be almost the opposite ranking from HIC. In both cases they were

[15]Equity was ranked highest in mid and low-income countries and gender in high income countries.

in the top ten[16] or so choices. Changing behaviors, interactions with new mobility options, the use of technology and apps were seen to be of higher importance for HIC. Although they were still of interest; they were ranked low for MIC and LICs and were not to be consistently found in the top ten.

Recurring and Persistent Research Gaps

Recurring research gaps included all forms of data collection (generally and disaggregated e.g., by trip purpose and gender), governance issues, and evaluation tools to show the impacts of active transport (see **Figure 2**). These were seen as the most important and highest priority areas for research based on the respondents ranking of these topics in the survey.

As mentioned, lack of sufficient data was one of the most frequently mentioned knowledge gaps (in the survey comments, interviews, and literature) and thus is highlighted as a core research need. Triangulating this with ranking of the thematic findings and the interviews, one can conclude that data to highlight equity, gender, and social and economic inclusion aspects of active transport are also lacking. There were more responses from the Global South that reflected a heightened interest in this, which is not considered to be surprising. Transport data for all modes in many countries of the Global South is relatively poor (Barbero and Uech, 2012; OECD/International Transport Forum, 2013). The authors' observations from working in several countries and confirmed by comments in the survey is that data collection is frequently project, rather than needs driven, and usually focusses on motorized rather than non-motorized movements[17].

Results from the survey and interviews indicated that there were few tools developed to show the positive impacts of active transport. This was ranked as the fourth highest need for future research. However, this result conflicted with the findings from the literature review. Few of the tools that are available for either walking or cycling were mentioned in either the survey or interview responses (apart from a handful of prompted mentions in the interviews). This is somewhat surprising considering the relatively large number of tools available and the recent explosion in mobile phone apps. Nonetheless, based on the survey comments there is a need for tools that show the benefits of active transport modes, rather than focusing exclusively on their disadvantages when compared with faster, motorized modes. Such tools could also better position active transport to become a priority for policy development and/or investments at national and local levels. Thus, we conclude that there are gaps in the development of tools and many tools that are available are not well-known and/or may not be easy to access for researchers or practitioners, especially in emerging economies. It is also likely that the tools cannot be fully utilized because the data for these modes is generally poor. This study did not review the tools available, and their functionalities were not mapped.

The interactions of walking and cycling with new mobility modes, policies on allocating urban space between motorized and non-motorized modes, light vehicle standards (e.g., speed restrictions for e-bikes) and taxes, and how these intersect with social economic aspects such as equity, gender, age and income are also seen as research areas where there are significant gaps (in all regions). Many of these topics were ranked high in HICs and are seen to be of particular interest to city authorities in the Global North. Some city forums have developed briefing papers on these topics (e.g., POLIS or CIVITAS[18]), but these are usually not commissioned outside as part of research agendas.

Inadequate Attention to Active Transport in Transport Studies

There was universal agreement from those surveyed and interviewed that the subject of active transport was neither widely supported nor well taught in transport education. This was cited most strongly in respect to transport studies in the Global South. It appears that the topic is frequently considered as a soft, less technical, aspect of transport, offered as an option rather than a mandatory module within transport-related subjects. These views were expressed by both those who teach and those who study based on responses from educators and students based on quotes from the comments in the survey and interviews[19]. The students felt that this field of transport studies is less likely to result in attractive and income generating jobs on graduation compared to other branches of motorized transport such as road, rail, or logistics and the educators themselves had usually not studied these modes when they trained. Additionally, it was observed that those interested in this topic are often themselves keen cyclists or walkers, and it is through this personal interest that they have furthered their professional work. This aspect of our study is considered to present a new insight into the gaps in the evidence on active transport.

Terminology Used and Negative Associations With Walking and Cycling

One question in the survey explored the terminology and relationship between active transport and non-motorized transport (NMT). This was designed to attempt to determine any perceived differences, the extent to which respondents preferred or felt more (or less) comfortable using one or the other term and how respondents perceived the interchangeability of them. The results were inconclusive. Forty eight percent of respondents indicated that the terms mean different things, i.e., they should not be used synonymously. An almost equal amount (47%) indicated that there are insignificant or no differences, and the terms can be interchanged. The remaining 5% recognized that there are differences between the terms but were not specific about what those differences are.

Many of the study respondents were more comfortable using the term non-motorized transport, while others strongly opposed this. They felt that using "motorized" as a reference point placed it at a lower level of importance, especially for policy development

[16]Eight thematic topics were selected as these were the most consistently selected by respondents in both regions.

[17]In other words, data is collected to support a particular project rather than to understand the mobility needs of a city or region.

[18]City networks (mainly European).

[19]Some masters and PHD candidates took part in the survey.

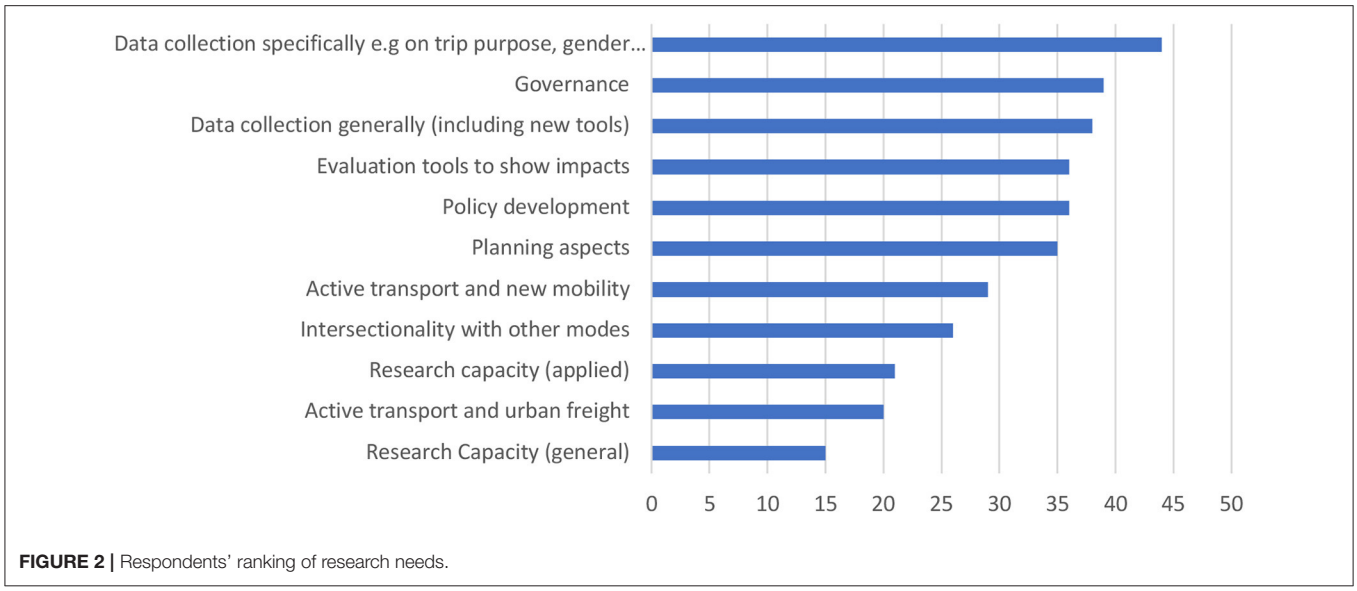

FIGURE 2 | Respondents' ranking of research needs.

and investments. For them it implies that being motorized is more "advanced, or developed," suggesting that walking and cycling are somehow associated to poverty and a lack of development, reducing their importance as transport modes. Yet another group felt strongly that assisted modes (such as electric bikes), light vehicles and shared modes are not part of active transport (transportation). However, it should be noted that in the literature search non-motorized transport picks up papers that are transport related, compared to using active transport which also identifies some medical papers or non-transport related publications. There were also several respondents who disliked both terms and proposed "walking and cycling (for transport)" or "walking and cycling (for travel)."

TOP TEN RESEARCH GAPS

By triangulating the survey responses, interviews and identified literature gaps, using a simple system based on the ranking of importance and mentions. This allowed us to identify convergence, complementarity, and divergence between the various responses and regions. The following list indicate the top ten priority areas[20] for future research for all regions:

- Data collection on all active transport modes and specifically disaggregated data e.g., on trip purpose, and including equity and gender aspects.
- Governance (including institutional and societal aspects).
- Policy development (including changes due to COVID-19).
- Planning aspects.
- Evaluation tools to show positive impacts.
- Active transport and new mobility.
- Intersectionality with other modes (including comparing modes, e.g., cycling with rather than vs. walking).
- Safety and security, especially what creates safe and secure environments for active transport, and how does lack of safety and security impact choosing these modes.
- Research capacity (generally and applied).
- Urban freight.

This list was also validated by a reference group selected from the respondents and the interviewees. It was also presented in two workshops to gather further input. The integration of active transport in the design of built environments with respect to interactions with other traffic, mobility choices, accessibility, livability, and quality-of-life/wellbeing, were also widely supported by the reference group. These aspects could be considered to be part of the planning aspects in the list above.

Both the thematic topics and priority research areas can be further clustered and grouped, with improved educational support as cross-cutting horizontal themes and this may be helpful for contextualizing further research. The key thematic and priority areas can also be further mapped to highlight interactions between them. For example, getting more women to cycle can be associated with poverty reduction. Similarly, the societal and technical aspects of equity and planning may improve livability, as well as, supporting the overarching objectives of achieving the SDGs.

DISCUSSION ON THE FINDINGS

According to the literature review, both cycling and walking have received more research attention in the past decade yet based on the survey this large and growing body of research has not been incorporated into transport planning and investments, especially in the Global South. Based on the review of academic and policy papers and from feedback received in the interviews, cycling is valued more highly as a transport mode (particularly in urban contexts) than walking. Although walking is widely accepted as being part of a healthy, lifestyle choice with a large body

[20]Not necessarily in order of importance.

of research highlighting these benefits (as published in health-related journals), it is largely undervalued (beyond the individual health benefits) as a transport mode.

Walking as a means of transport is commonly used for short trips, but data on this is poor in all regions. According to the European Commission[1], it is difficult to assess data and information on pedestrian mobility at country level, as most national travel surveys do not include short trips (in distance and time). Additionally, the walking sections of trips made when traveling by public transport (as well as other trips of 15 min or less) are often not counted in national travel surveys. Thus, the importance of walking is underestimated.

Furthermore, as these trips are frequently not included in the demand-based models used for planning and investments, they are not included in investment planning. Therefore, the evidence for policy development for including walking as a transport mode, tends to be weak. This results in a lack of visibility in policy and investment contexts, especially in the developing world. The author also concluded that cycling as a transport mode is given more strategic importance compared to walking, and this finding was validated by the survey and the interviews. It should also be noted that many papers in transport journals highlight the dangers of walking and cycling, rather than the benefits.

The absence of technical capacity in walking and cycling at city and national levels in many emerging economies, and the lack of safe infrastructure to encourage the use of these modes, is frequently highlighted in published papers and reflected in the survey findings. Based on observations and the discussions in the interviews, the lack of support for active travel in transport education can also be linked to the personal experience and professional bias of those teaching transport an engineering. Faculty teachers, themselves, may not have been fully exposed to the value of these modes either professionally or when they were being educated, and thus these modes are not promoted to students with the same level of vigor and enthusiasm as motorized modes. The following specific comment was made by an interviewee: "Interest in motorization is seen to be a pathway toward academic achievement." We conclude that the combination of poor active transport data and the lack of a robust pipeline of competent and trained transport and planning professionals supporting this mode, hampers its development, especially in the Global South[21].

There is considerable debate in academic and practitioner circles regarding the terminology used. People have strong opinions expressed in the survey comments and interviews. Active transport is a relatively new term but one that has been gaining support over the past decade as an alternative to "non-motorized transport" (NMT). Active transport and active travel for transport were seen to more readily include the new and emerging modes. Nonetheless, there are passionate and polarized views regarding which is the best expression to use (active transport/travel, non-motorized transport or walking, and cycling).

[21] This would include mid-income regions.

In the survey, several respondents clearly felt that active transport meant human powered transport[22] only and excluded all types of light motorized vehicles, whiles others indicated that they were happy to include such modes. The term should encompass the different needs and contexts of all forms of walking and cycling, including for instance walking or cycling for leisure[23] (although this was outside the scope of this study). On the other hand, NMT is already widely used and accepted as a term to mean walking, cycling and human powered transport, and is cited in many papers. It also fits well with database search engines as a searchable key word to locate published work. Taking all the views expressed in the survey and interviews into account, the author concluded that the terms active transport and active travel (for transport) seem to connect more strongly to the mode's positive attributes (such as health benefits) than the term NMT, but no consensus could be drawn from the results of the study.

IMPACT OF COVID-19 PANDEMIC

While recognizing that it is still too early to determine if COVID-19 has resulted in any permanent behavioral changes with respect to active transport, there is a growing body of documentation to support that it has had a temporary positive effect. Short-distance travel and home working have become more widespread largely due to government lockdown restrictions and there are further indications that travel behavior changed significantly during the pandemic. More people are cycling, walking locally and, in many cases, not making or reducing their daily commutes to their place of work. In addition, they are less likely to visit town and city centers as frequently as before, and when they do personal space has become more important.

There has been an increased interest in active transport especially with respect to cycling, and to some extent, walking during the pandemic. This appears to be quite pronounced in the Global South, and especially in Africa (UN, 2016). From the few recent papers reviewed, there are numerous examples that show more local walking trips and an increase in cycling. For example, some studies show that if men and women learned to ride a bicycle in their youth, they were more likely to have taken up cycling again during the pandemic when motorized travel was banned (for example in Uganda) (Jennings et al., 2020). These new active transport behaviors are seen to have increased the resilience of urban populations where they have occurred during the pandemic. As a result, many city governments have awakened to the importance and value of active transport modes as a component of local resilience, and important for citizens' physical and mental well-being. Temporary "pop-up" interventions, such as bike lanes, parklets, and wider sidewalks have been introduced in some places as measures to accommodate the need for social distancing and the need to be able to walk or cycle. There are also indications that

[22] This included some mechanised transport such as pedal bikes and rickshaws.

[23] Walking or cycling for leisure can be considered to be part of active mobility, but in the author's opinion as they lack a transportation purpose it should therefore not be classified as active transport.

existing plans for implementing cycling and walking measures have also been accelerated, especially in the Global North.

CONCLUSIONS

Research in this field remains fragmented and numerous gaps between research and practice, as well as many research questions still to be addressed. This is particularly apparent in middle- and low-income countries of the Global South. This study applied simple mixed method research approaches in a new and innovative way that can easily be further developed and replicated. The study showed that there is a very large body of evidence about active transport, but the current topics and presentation are not being taken up in practice. This observation was based on the results of the literature review and was clearly reflected in the responses to the survey, especially from those in the developing world.

Despite the large body of research identified in the literature review, many studies and much of the information has remained within academic communities and has not attracted the attention of politicians and decision makers. As a result, implementation of research findings is weak. A general observation from the survey results is focus on promoting modal shift (usually from motorized to non-motorized modes in the Global North and vice versa in the Global South) toward active transport, rather than encouraging citizens to consciously choose active modes as a transport choice.

The results of the literature review and the interviews indicate that some progress has been made on collecting information and data, but it is not equally shared between walking and cycling. Data on walking as a means of transport is seen as being poor despite wide acceptance that pedestrian data provides vital information to planners, engineers, designers, public health professionals and others working in this field. Indeed, data on walking appears to be lacking everywhere. Despite this, it is well-documented that walking is by far the dominant mode of transport for much of the developing world. Neither walking nor cycling get much policy or investment attention compared to motorized transport, especially in the Global South. The evidence base used for planning and investments due to the lack of robust data is also weak.

A lack of data and tools were consistently mentioned. Yet there are numerous tools and several data sets available. However, they do not seem to be well-known nor widely used as few were mentioned in the survey. Thus, there would appear to be some "road-blocks" between the topics chosen by the research community and what is required by the practitioner communities.

In part, this is likely to be due to the lack of data, but also likely to be due to the way transport models and tools (in particular cost-benefit analysis) that are widely used to influence investment decisions, undervalue walking. Walking as a means of transport is mostly used for short trips (15 min or less) and many national travel surveys (or other surveys) omit to collect such trips. In addition, travel surveys often ask for the "primary mode used." As walking is often part of a longer trip that includes using motorized modes, the motorized trip is usually counted not the pedestrian part. Examples of this practice include the walking sections of a public transport trip, which are also not usually counted. Thus, it is difficult to assess the extent of pedestrian mobility or its relevance if these models are used to drive decisions. Investigating such aspects of active transport may provide insights that can be used to integrate and mainstream active transport more effectively into transport planning.

From the findings of this study, it can be assumed that the importance of walking in transport is still largely underestimated, especially in emerging economies. Walking despite being well-documented as the dominant mode of transport in much of the developing world, is not seen as a major mode of transport (in the Global South or indeed anywhere). Road safety aspects for both modes were highlighted especially in papers from the Global South (Gwilliam, 2002; UN, 2016). Cycling is considered as a mode of transport, a sport, and a leisure activity in the Global North, with papers covering all three of these aspects. Walking is also considered to be a sport, a leisure pursuit and lifestyle choice but more rarely a transport mode.

Cycling has enjoyed a higher level of interest and investments during the past decade. Its importance as a transport mode (especially in urban areas) has increased in the same period. On the other hand, walking is still mired in debate regarding its value in the transport mix and suffers from a lack of visibility in both public-policy and investments contexts. This also means that planning and investments decisions about active transport are frequently not data driven. This appears to be more pronounced in the developing world.

Barriers and enablers vary widely and under researched topics include economic and distributional aspects, social norms, education, how they intersect with active transport. For example, as mentioned in the interviews, girls are allowed to cycle to school in some communities (particularly in Asia and Africa), but once they become women, they are not able to cycle in public spaces[2]. This constrains women's mobility and access, as they have fewer transport choices in adulthood.

The current terminology used could benefit from being re-framed, enabling non-motorized modes to be (re)presented to policy makers, investment decision makers and funders of research in a more dynamic and integrated fashion. This is seen as being particularly necessary to help get walking recognized as a transport mode. Pedestrians are often classed as "walkers," i.e., citizens who walk for pleasure rather than as a means of transport. Moreover, much of the literature on walking is focused on pedestrians as vulnerable road users, documenting vehicle-pedestrian collisions and lack of pedestrian safety, all of which reinforces a negative image of walking as a transport mode. This is also true to a lesser extent for cycling. The cultural dominance and convenience of the motor vehicle has led urban space to be allocated disproportionately to meet the needs of these vehicles, to the detriment of pedestrians and cyclists. Until walking and cycling are more widely recognized as transport modes in their own right, it is likely that car owners/drivers will continue to win the competition for urban space.

Many of these observations are not new and have been noted before. Planning and investment processes are slowly changing, and data is beginning to be collected in new and innovative ways but including information and data on the active modes is not yet mainstream and this needs to be amplified and accelerated. Building a more robust understanding of all types of active modes and their benefits, especially walking, could be a useful addition to the international research agenda. Additionally, other identified research gaps such as recognizing walking as a transport mode, improving tools, assessing the economic impacts, and equity and gender aspects would all help to build a stronger evidence base for political and financial support for the active modes of walking and cycling.

Transport does not merely serve society but is also shapes it. Thus, in the face of the current uncertainty about future transport demand[24], people's mobility needs to be redirected away from fossil fuel based motorized transport toward low carbon sustainable modes and for them to be more attractive to more people. For this we need different and more targeted research on active transport modes.

Current perceptions about active transport appear to hamper investments (based on survey replies and comments about a lack of infrastructure and investment). Over the years the dominance of the predict-and-provide transport planning and models have overlooked walking and cycling and resulted in a lack of in-depth, quantitative, and qualitative studies of active travel/mobility behaviors.

A change in our current paradigm is certainly called for, but robust evidence and new research will be required to support that change and provide an opportunity to re-frame and re-invigorate political and practitioner perspectives on active transport and travel. There is no lack of scholarship in active transport but despite the significant amount of published research, it has not resulted in committed implementation by practitioners. New knowledge should support the realization of a desired low carbon mobility future. Crucially, a shift toward a "decide-and-provide," rather than a "predict and provide," approach that includes active transport modes more directly may help us negotiate the deep uncertainty brought about by changes beyond our direct control, such as the COVID-19 pandemic and/or the extreme weather events associated with climate change.

[24]Based on the mobility behavior changes noted during the pandemic.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the original datasets have not been shared outside the researchers involved in the project. Requests to access the datasets should be directed to heather@heatherallen.co.

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 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.

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REFERENCES

Barbero, J. A., and Uech, L. (2012). *Assessment of Transport Data Availability and Quality in Latin America, IDB Inter-American Development Bank, Washington D.C.; United Nations Economic and Social Council (2009) Report on Transport: Prepared for the Eighteenth Session of the Conference on Sustainable Development Addis Ababa, Ethiopia Africa; Asian Development Bank* (2019). Available online at: https://data.adb.org/dataset/asian-transport-outlook-database.

ECF (2019). *European Cycling Federation Unlocking Cycle investments*. Available online at: https://ecf.com/unlocking-cycle-investments (accessed August 2021).

Gwilliam, K. (2002). *Cities on the Move: A World Bank Urban Transport Strategy Review*. The World Bank, Washington, DC. Available online at: https://openknowledge.worldbank.org/handle/10986/15232

Jennings, G., Allen, H., and Arogundade, E. (2020). *Gaining or Losing Ground: Ensuring that Post-COVID-19 Transportation Serves the Needs of Women in Low Income in African Cities*. High Volume Transport Applied Research; COVID-19 and Transport Response and Recovery. Available online at: http://transport-links.com/download/gaining-or-losing-ground-ensuring-that-post-covid-19-transportation-serves-the-needs-of-women-in-low-income-sub-saharan-african-cities

Let's get Scotland walking (2014). *Let's Get Scotland Walking - The National Walking Strategy* (2014). Available online at: https://www.gov.scot/publications/lets-scotland-walking-national-walking-strategy/ (accessed *August* 2021)

OECD/International Transport Forum (2013). *ITF Transport Outlook 2013*. OECD Publishing /ITF.

Rotterdam Walk Project Team (2020). *Rotterdam Loopt*. Available online at: www.rotterdam.nl/lopen www.rotterdam.nl/lopen (accessed *August* 2021)

UK Department for Transport (2020). *A Gear Change for Cycling and Walking*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904146/gear-change-a-bold-vision-for-cycling-and-walking.pdf (accessed *August* 2021).

UK Government and Department for Transport (2020). *UK Government Active Travel: Increasing Levels of Walking and Cycling in England (Policy Paper)*. Available online at: https://publications.parliament.uk/pa/cm201719/cmselect/cmtrans/1487/148708.htm (accessed August 2021)

UN (2016). *United Nations Environment (UN Environment) (2016) Global Outlook for Walking and Cycling (Policies and Realities From Around the World.)* UN Environment, Nairobi.

WHO/Europe (2019). *Health Economic Assessment Tool (HEAT) for Cycling and Walking*. Available online at: http://www.euro.who.int/HEAT.

Wittink, R. (2001). *Promotion of Mobility and Safety of Vulnerable Road Users: Final Report of the European Research Project PROMISING (Promotion of Measures for Vulnerable Road Users). D-2001-3*. SWOV Institute for Road Safety Research, Leidschendam and European Commission Mobility and Transport Walking and Cycling as Transport Modes Available online at: https://ec.europa.eu/transport/road_safety/specialist/knowledge/pedestrians/pedestrians_and_cyclists_unprotected_road_users/walking_and_cycling_as_transport_modes_en#_1.2.1_

World Bank (2019). *Sustainable Mobility for All SUM4ALL*. Global Roadmap of Action Toward Sustainable Mobility. Washington DC.

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.