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Collaboration between physical activity researchers and transport planners: A qualitative study of attitudes to data driven approaches

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A B S T R A C T

Collaboration between physical activity (PA) researchers and transport planners is a recommended strategy to combat the physical inactivity epidemic. Data collected by PA researchers could be used to identify, implement and evaluate active transport (AT) projects. However, despite aligned interests, researchers and transport planners rarely collaborate. This study utilized qualitative methods to 1) gain an in-depth understanding of the data utilized in AT planning, 2) explore the utility of Global Positioning Systems (GPS) and accelerometer data in supporting the planning process, 3) identify the benefits and barriers of researcher and transport agency collaboration, and 4) identify the facilitators to collaboration for these groups. Semi-structured interviews were conducted with 17 transport modeling, planning or engineering professionals, transport agency directors, and academics with relevant expertise in health or transport planning. A thematic analysis was conducted following structural coding by two researchers. The analysis revealed that geographic and physical activity data that are current, local, objective and specific to individual AT trips would improve upon currently available data sources. Informants believed that research collaboration could increase capacity by providing unbiased data and access to students to assist with targeted research. Collaboration could also increase the relevance of academic research in applied settings. Identified barriers included: setting up contracts, lack of policy and planning mandates that include health, a disconnect between research interests and agency needs, and competing priorities. Researchers may need to initiate discussions with AT practitioners until health is formally included in the planning process as the first step in understanding data needs and identifying mutual research interests. However, regulations that link health and physical activity metrics to funding, as well as training programs that incorporate public health and transport planning, are needed to encourage cross collaboration.

1. Introduction

Physical inactivity is a major public health concern as it is associated with obesity, increased risk of chronic diseases and premature mortality (Lee et al., 2012). Yet, less than twenty percent of adults in the U.S. meet the physical activity (PA) recommendations (Troiano et al., 2008). Those who commute by active forms of transport accumulate more PA overall and are more

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likely to meet the recommended guidelines than automobile commuters (Dill and Toulan, 2009; Lachapelle et al., 2011). Despite this, walking and cycling represent only 11% and 1% of trips, respectively, in the U.S. (Federal Highway Administration, 2011).

Metropolitan planning organizations (MPOs) are the primary regional transport agencies in the U.S., responsible for transport investment and planning in urbanized areas that, when combined, cover 80% of the population. MPOs have historically sought to mitigate public health issues such as traffic injuries and air pollution exposure, in response to regulations and funding. The focus on active transport (AT), however, is a relatively new strategy to address transport related issues like parking demand, traffic congestion, and greenhouse gas emissions, while also improving health. Safety concerns present a significant barrier to people engaging in AT (Cerin et al., 2017; Fowler et al., 2017; Kerr et al., 2016; Saelens and Handy, 2008), and studies have shown that the presence of high quality sidewalks and cycling infrastructure promotes PA (Active Living Research, 2009; Dill and McNeil, 2016). Thus, transport planning that supports AT infrastructure provides a key strategy in combating the physical inactivity epidemic.

Travel demand models utilized by transport agencies to guide infrastructure investments and decision making have traditionally focused on improving level of service for motorized vehicles (Aoun et al., 2015). Recently, models that accommodate AT trips have been implemented in select regions, however objective walking and cycling data to inform these models is lacking (Alliance for Biking and Walking, 2016; Aoun et al., 2015). Agencies are often reliant on national travel surveys that vary widely in methodology and the geographic scale of data aggregation. As a result, there are large discrepancies in AT estimates, which introduce error when applied at the local level (Mansfield and Gibson, 2016). Health researchers now increasingly use devices to capture location and activity data. Research grade Global Positioning Systems (GPS) sensors typically collect location information every 15 s, with a median accuracy of 3 m, and PA is objectively assessed using hip and wrist worn accelerometers (James et al., 2016; Schipperijn et al., 2014). These two data sources can be combined to identify transport trips and provide mode and route choice information.

Collaboration between PA researchers and transport agencies to combat physical inactivity through transport planning has been recommended for some time (Hoehner et al., 2003; Sallis et al., 2004; Schmid et al., 2006). Yet, little progress has been made toward integration of PA into planning goals. A recent review of regional transportation plans found few with stated PA goals and even fewer with specific performance metrics (Singleton and Clifton, 2016). MPOs in a recent national survey reported they lack suitable data to expand performance measures beyond those that are federally required, to include health and multi-modal transit (Davis, 2017). Despite this identified data need, the use of data not specifically collected for transport planning purposes and the process of collaborating with other sectors is not well understood. The impetus for this research was to understand how location and PA data, collected for health research purposes, might also inform AT planning and decision making, thereby expanding the applied utility of the data. This qualitative study capitalized on the existence of both research and transport experts in San Diego, CA and aimed to:

1) gain an in depth understanding of what data are utilized in AT planning,
2) explore the utility of GPS and accelerometer data in supporting the planning process,
3) identify the benefits and barriers of researcher and transport agency collaboration,
4) identify the facilitators to collaboration and to suggest areas for further exploration.

2. Materials and methods

The REACH group (Research in Environments, Active aging and Community Health), at the University of California, San Diego, conducts studies on the relationship between the built environment and health. The group has expertise in the collection and analysis of objective data on location and activity, including GPS and accelerometry. Likewise, the San Diego Association of Governments (SANDAG), the regional planning organization for San Diego County, has led efforts to include AT and health in planning (U.S. Department of Transportation, 2012). SANDAG funds projects that encourage AT through the state Active Transportation Program and has partnered with the County's health agency on two CDC funded grants; initiatives in which REACH researchers were involved ("SANDAG Active Transportation Program," n.d., "SANDAG Public Health White Paper," n.d.). Despite joint efforts, meaningful interdisciplinary collaboration has not been maintained.

This study followed a general inductive approach, using semi-structured interviews to identify themes related to the research aims. The Innovation-Decision Process, described in Rogers' Diffusion of Innovations Theory, guided the development of interview questions (Rogers, 2003). Rogers postulated that the adoption of an innovation, i.e. a new idea or technology, occurs though a 5-step process (see Fig. 1). Interview questions focused on the Knowledge and Persuasion stages, probing about previous practices, planning needs and perceived characteristics of research data and academic collaboration.

Interviews were conducted, either in person or by phone, between March 2015 and November 2016 by the first author (KC). A purposive, snowball sampling strategy was used to identify participants with in depth knowledge of AT modeling, planning, implementation or related research (Creswell, 2007). Recommendations for future interviewees were solicited at the end of each interview. All individuals contacted for an interview agreed to participate. Though the main focus of this study was on San Diego, participants were purposefully recruited from different geographic regions in the U.S. to provide broader experiences. The sample size was driven by the desire to have different perspectives within AT practice, and to reach sufficient saturation in responses. All interviews were conducted by the lead author. Key questions were emailed to participants prior to the interview to facilitate recall. A standard interview guide was utilized, though the semi-structured interview format allowed for flexibility given the varying roles of participants. See Appendix A for an example interview guide.

The study was reviewed by the UCSD Institutional Review Board and received a Certification of Exemption (protocol #150657XX). The interviews were audio recorded, and all participants provided verbal consent. To preserve confidentiality, participants did not state their name on the recording and any names mentioned in the interviews were anonymized during

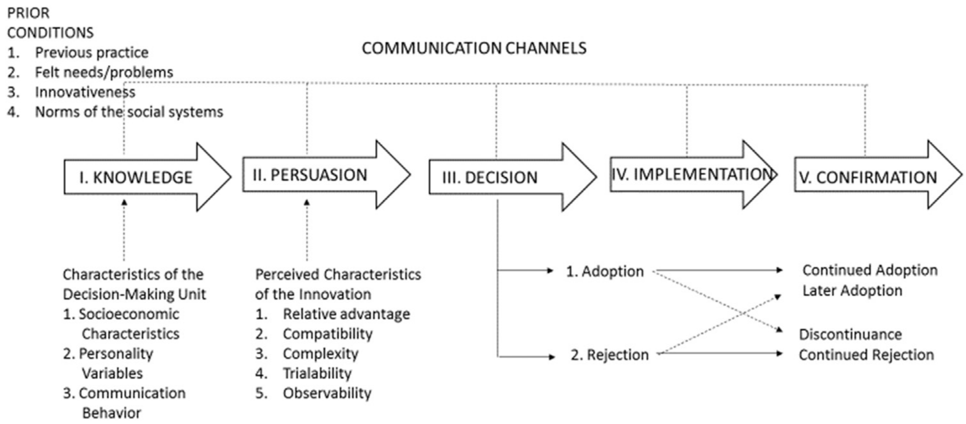

Fig. 1. Model of the five stages of the innovation - decision process (Rogers, 2003).

transcription. Participants were not compensated for their time.

2.1. Data analysis

The interviews were transcribed verbatim by an external transcription service. All transcripts were coded by both members of a two-person coding team, including the lead author, to reduce potential bias of interviews being conducted by KC and to achieve consensus. Both coders were members of the REACH team and have received formal qualitative training in coding and analysis. A thematic analysis was conducted following a structural coding approach by labeling data according to topics of inquiry. This method is particularly applicable to interviews aimed at extracting major categories or themes (Saldana, 2016). Both coders first read the transcripts to familiarize themselves with the content and "pre-coded" the data, making notes and highlighting significant passages. Eight interviews were coded together to develop the codebook (MacQueen et al., 1998; Weston et al., 2001). KC then coded seven additional interviews independently, using a constant comparison method to adapt and refine the codebook. A final round of tandem coding was completed on all interviews in which discrepancies were discussed in depth to ensure consensus (Harry et al., 2005). Saturation was determined by both coders when no new information was presented and no new codes were generated in the final two interviews. Coding was performed using the Dedoose (Version 7.5.9, 2016) web application (Los Angeles, CA: SocioCultural Research Consultants, LLC (www.dedoose.com)).

3. Results

A total of 17 interviews were conducted with modeling, planning or engineering professionals, transport agency directors, and academics with relevant expertise. The sample was evenly split between those working in San Diego and other large U.S. metropolitan areas. Directors and technical or program managers within MPOs comprised the largest subgroup. AT planners (those developing projects) and modelers (those developing the forecasting tools used in planning) comprised the next largest groups. Participant characteristics are outlined in Table 1. As interview questions were developed to probe the Knowledge and Persuasion stages of the decision process, codes aligned with attributes of those steps (Rogers, 2003). The Knowledge stage is informed not only by the innovation itself, but by prior conditions such as previous practices and whether the individual felt the need for the innovation. Thus, participants were asked about data that currently support their work and how satisfied they were with those sources. Persuasion is when an individual seeks more information on the innovation and forms an opinion. It is informed by attributes, or perceived characteristics, of the innovation. Codes like "benefit or limitation of research data/collaboration", "facilitators or barriers to data source use/collaboration", "" and "priorities" mapped to these categories (see Table 2). Results are presented according to the main interview topics.

3.1. AT data sources, satisfaction, use, and output

Public data like the U.S. Census, American Community Survey and NHTS were frequently cited sources of demographic and travel behavior inputs for forecasting models and project planning because of their wide availability. Paper based, regional household surveys that capture self-reported travel behaviors were another common source of AT data. Specific to cycling, the transport modelers, planners and engineer reported using cycle counts in addition to Strava data, a mobile app that tracks activity from GPS enabled devices (https://www.strava.com/).

Most respondents felt confident using surveys for population demographic estimates, however they expressed concern about applying regional level cycling and pedestrian behavior data to localized project corridors. For example, one informant commented that when using these sources,

Table 1
Participant characteristics.

Characteristic	N = 17 N (%)
Gender	
Female	7 (41)
Location	
San Diego	9 (53)
Other	8 (47)
Role	
Planner	4 (24)
University Faculty	2 (12)
MPO Director or Manager	7 (41)
Travel Modeler	3 (18)
Engineer	1 (6)
Organization Type	
MPO	11 (65)
University	2 (12)
Research Organization	2 (12)
Consulting Firm	1 (6)
City	1 (6)
Seniority (by job title)	
Senior	14 (82)
Junior	3 (18)

Table 2
Codes aligned with the innovation - decision process (Rogers, 2003).

Model Stage	Inputs to model stage	Codes
Knowledge	**Prior conditions**	
	Previous Practice	Previous or current practice
		Current data sources
		Collaboration experience
	Felt needs/problems	Felt need for change in practice
		Satisfaction with current data source
	Innovativeness	Benefits of research data
	Norms of the social system	Role and Organization
	Characteristics of the decision-making unit	Priorities
		Regulations or requirements
		Facilitators to changing previous practice
		Barriers to changing previous practice
		Modeling, planning, decision making process
		Health
Persuasion	**Perceived characteristics of the innovation**	
	Relative advantage	Benefits of research data
		Benefits of collaboration
	Compatability	Previous or current practice
	Complexity + Trialability	Barriers to changing previous practice
		Barriers or limitations of research data use
		Barriers to collaboration
		Facilitator of collaboration
		Facilitator of data use
	Observability	

[*]definitions taken from Rogers (2003).

> "We're making a lot of guesses. Not cutting corners, but leaps of faith… But it's what we have available right now." [technical manager].

Participants conveyed several concerns about travel surveys. First, these surveys are conducted relatively infrequently; most reported a 10-year interval between collection. This gap is problematic for planning as travel behaviors were likely to change across that time period. Second, AT trips, especially cycling, represent a very low proportion of total transport mode share, thus without oversampling it is difficult to collect sufficient information.

> "Normally when we do a Household Travel Behavior Survey we don't oversample bike and walk travel. So, particularly for bike, you end up with very small sample of bike trips. So, that's not good for creating a reliable bike and walk model." [modeler].

In addition to being infrequent, AT trips are often very short or incidental, and thus go unreported. Travel surveys conducted without GPS do not provide information on the actual route taken. Route information improves model predictions, as otherwise the shortest route between origins and destinations may be assumed. The time and cost of collecting and analyzing GPS data were mentioned repeatedly as barriers. Some respondents had previously collected GPS or were going to include GPS data in future travel surveys, however the capacity to analyze it was lacking. A participant stated,

> "We did a survey– a home interview survey where we equipped three thousand households with wearable GPS devices and we have not had the bandwidth to look at that data at all." [planner].

Cycle counts were used for various purposes, including validating models (i.e. whether the model predicts the number of trips accurately), informing project locations, and project evaluation and monitoring. The main limitation with counts was the lack of route information. There were also issues with the quality of data capture,

> "…not everybody's necessarily going over the tubes … They're in the buffered bike lanes, but there are people that ride on the other side and those people don't get counted." [planner].

Participants also expressed difficulty maintaining automated cycle counters as they lacked the funding to perform the frequent calibrations required to maintain accurate counts. Though Strava data provides route information which could help calibrate models, participants were concerned with both the cost and representativeness of the data. For example,

> "I think it's going [to] be over-representative of recreational trips rather than utilitarian just because of how it started out. The second thing is, I think it's going to be over-representative of a very specific demographic … there's plenty of people who bike because they have to and it's not going to capture those people." [planner/data analyst].

In general, responses indicated that the type and degree to which data were used varied greatly by the role participants had in the planning process. For example, planners predominantly reported using personal and professional knowledge of a project area in developing projects.

> "We're not really doing much with data. A lot of it really has to do with our personal knowledge of the project area and what we've observed when we're out there." [planner].

In contrast, transport modelers required very detailed trip and demographic information to build accurate travel demand models. The two things on which all respondents agreed was the desire for local and current data. For modelers, this would improve the accuracy of projections, and for planners, it would provide examples that the public and decision makers can relate to and understand.

Preferences in data output also differed by role. Planners described the need for easily presentable data that could generate public and political will for projects. Case studies that relayed stories and animations of AT trips, for example, were viewed as influential tools for project outreach; however, data in these formats were of little use to modelers or analysts. With regard to project implementation, participants stated that little evidence exists to link facility type to increased use. Data supported evaluation of the increase in AT trips associated with different facility types (i.e. bike lane vs. separated cycle track) would convey clear return on investment to decision makers.

3.2. Benefits of GPS & accelerometer data

Transport professionals and researchers expressed interest in objective route and physical activity data, which they do not typically have access to. Local, objective trip data was seen as a major asset in order "to be able to really calibrate and understand the real choices that people are making." [modeler] GPS data provides route information as well as trip origin and destination. This was important as the characteristics of the route and alternatives not taken can then be modeled to determine what factors encourage walking and cycling and inform future investments. As a participant explained,

> "the traditional transportation data doesn't have the granular detail that some of the newer models really can use now." [transportation director].

Additionally, GPS traces, or movement trajectories, before and after project implementation can reveal how new infrastructure affected utilization of surrounding routes, i.e. what routes people gave up to use the new infrastructure. Because GPS captures all trips, including short ones that are often unreported in traditional surveys and thus left out of models, the data could be used to validate transport surveys.

Participants reported the increased inclusion of health in policy objectives, both at the national (through policy setting organizations) and local levels (in regional and community plans). A few indicated new models that forecast the impact of mode shift on health outcomes, like the Integrated Transport and Health Impacts Model (ITHIM), could utilize these data. PA had been included in the transportation plan in one region, however assessment metrics were unknown.

3.3. Barriers to use of PA research data

Participants were asked what challenges might exist to using data collected by PA researchers. One concern was the relatively small sample sizes of research studies that utilize sensors compared with large transportation surveys. However, participants universally agreed that the benefits of having objective cycling and walking specific data far outweighed this limitation. In current practice, modelers are forced to make numerous assumptions given that AT data are extremely limited. One participant stated,

> "As long as the data lets us be more thoughtful than our current approach … I don't think sample size is too big of a deal." [principal planner].

Though many respondents thought objective AT data would be persuasive in the public planning process, some expressed doubt about its ability to sway opinion given the multitude of factors that drive decision making. As one participant described,

> "it's almost a fantasy that I should have somebody that's opposed to the project and then I can show them different studies and they say, 'Ah, of course'." [planner].

Others expressed uncertainty about whether data could definitively demonstrate a cause and effect relationship between infrastructure and demand.

3.4. Benefits of research and transport collaboration

One of the most frequently cited benefits of researcher and transport agency collaboration was the potential for accessing data that they did not have to collect, or pay to obtain. Some respondents indicated they would be willing to pay for data collection by universities if the data were specific to their needs. Research studies could provide an ongoing data source allowing transport agencies to validate the accuracy of their models and assumptions more frequently than survey waves permit.

Respondents indicated the procurement of local AT data was a major benefit of collaborating with a university conducting studies in their region. AT model enhancements have been led by a limited number of transport agencies, using region specific data. Those models have been adapted for use by MPOs in other areas where characteristics like weather, topography, and existing infrastructure vary and could therefore result in inaccurate forecasting. Incorporating local data would allow recalibration of models to more accurately reflect patterns for specific regions. Participants believed that local AT behavior and infrastructure utilization data would also be more influential with the public and elected officials. A senior engineer stated,

> "we're always pointing to what other people have done … and then people go but that's fine for them. You know, they're them, we're us and they don't relate to that connection."

Another benefit to collaborating with universities was that independently conducted research may be viewed as unbiased by the public. Many participants indicated that providing university backed research to elected officials would be beneficial. This was particularly important for those in planning and agency director roles. As one planner stated,

> "the politician can say, 'I'm not pandering to this group or that group. Here's this information. It's real, it's verified, it's correct."

Many respondents discussed the utility of academic collaborations to answer research questions of interest that they do not have the infrastructure, resources, or time to pursue. For some, academics were viewed as more autonomous and innovative. For example,

> "Government is motivated by following rules, not by innovation. It's not even that they don't prioritize that, it's like you're actively penalized for doing risky or interesting new things." [director].

Conversely, others suggested that researchers could benefit from the perspective provided by transport agencies for policy-relevant research questions and topics early in the study development process. Transport agencies could also assist with framing research results "… in a way that it is easily understood by policy makers and decision makers" [manager, information services] to increase impact. A significant benefit mentioned by respondents was gaining access to university graduate students who need to conduct thesis projects. As a former Director of Data and Analysis stated,

> "that comes back to us in spades later, when their dissertation just happens to be on exactly what we need."

Those who have previously collaborated with universities reported regularly hiring former students. Respondents indicated research collaborations would be useful as health becomes a more integrated component of transportation planning. As a Research Director stated,

> "… the effects of transportation infrastructure on health is something that we're dealing with more and more…So, it's not that the planning community or transportation community is ignorant of this concern, the problem is knowing how to respond to it."

Finally, the diversity of research study populations, in which the inclusion of underserved and at-risk groups is encouraged, was reported as an additional benefit of research data.

3.5. Barriers to research and transport collaboration

Participants discussed the general difficulty of changing existing practices in large transport agencies, including how data were collected and used. The difficulty of setting up contracts with academic institutions was one of the main barriers reported. Respondents indicated processes to execute contracts with consulting firms already exist, whereas developing agreements between a university and MPO, two large bureaucratic organizations, was incredibly time consuming. For example,

> "Contracting with a university is one of the hardest things we end up working on from a contracting perspective." [division manager].

Those who had previously collaborated with a university indicated these issues were resolvable, but required an individual willing to invest significant time and effort. Some expressed doubt that a university would be selected over consultant firms, with established contracts, to collect data.

Another frequently mentioned barrier was that university research did not necessarily address MPO needs. As a director of research explained,

> "a lot of the times when we work with universities there's a little bit of a disconnect between what they consider valuable and what we need."

Research was perceived by some as too theoretical, without having a direct application to practice. University Transportation Centers (UTCs), university-based centers that receive federal grants to conduct transport research, were perceived by roughly half of respondents as exacerbating this problem. Depending on location, universities that received funds were not always required to partner with local organizations. Some expressed that there was no oversight of what universities produce or how their findings were disseminated to the field. Several respondents mentioned university faculty turnover as a barrier to collaboration. Those with previous collaboration experience relayed examples of developing relationships with faculty who moved elsewhere, with no one remaining locally to continue the work.

An additional concern was the potential conflict between providing a deliverable and maintaining research autonomy. Whereas consultants have a product oriented approach, a university,

> "…wants to maintain its academic integrity and they don't want to be in a place where if they publish or provide results that are different than what the client or the City thinks are appropriate, …they don't want to be influenced." [director].

This inability to control research outcomes may be a barrier for agencies. Participants reported that health research, in particular, may further complicate an already complex planning process by introducing competing priorities. For example, as a participant expressed,

> "you can have an academic researcher that finds some relationship between the presence of air toxins and asthma, hypothetically…and then, you know, someone will run out and say, 'Well see, freeways cause cancer.' And well, maybe, maybe not … there's so many obstacles out there now that it's a little hard to say, 'Hey, let's have some more obstacles. Or more hurdles to jump over.'" [transportation director].

Lack of time, capacity and funding were also barriers to collaboration. There are many requirements that MPOs are legally mandated to address, such as greenhouse gas (GHG) emissions, to receive funding. Respondents indicated there was no capacity to take on non-mandated projects. Even if the collaboration has the potential to contribute funds, the investment in developing a grant proposal may not be worth it given the uncertainty of receiving the funding.

> "Grant opportunities are another thing we tend to shy away from… You want me to take people away from somebody doing concrete things to…spend time on getting a grant." [engineer].

Table 3 summarizes the benefits and barriers to research data use and university collaboration identified by respondents.

Table 3
Participant reported benefits, barriers and facilitators to research data use and collaboration.

	Benefits	**Barriers**	**Facilitators**
GPS and accelerometer research data use	Objective data Provides route information Captures short trips Data specific to AT behaviors Provides physical activity data	Sample size Data may not be persuasive or prove cause and effect	Improved/alternate data presentation
University and transport agency collaboration	Reduced data collection cost for agencies	Difficulty of changing existing practices	Understanding each other's needs
	Current and ongoing data source	Setting up contracts	Identification of mutually beneficial goals
	Local data	Research may not address MPO needs	Research tied to existing regulations
	University research perceived as unbiased	Faculty turnover	University initiator and champion
	Increased capacity to pursue useful research	Inability to control research findings	
	Increased research relevance in applied settings	May introduce competing priorities	Regular forum for meeting
	Provide student interns and potential employees	Lack of capacity to pursue non-mandated work	
	Provide health expertise		
	Diverse study populations		

3.6. Facilitators to collaboration

Participants identified what they thought was essential to forming successful collaborations (Table 3). While some felt UTCs have divided the field, half reported that UTCs with secured funding for transport research have succeeded in fostering collaboration with universities. The successful examples were cases in which universities actively sought out MPOs for research projects of joint interest. Identifying mutually beneficial goals and tying research to existing requirements was critical. Agencies have policies that they need to comply with, so collaborations that helped them achieve compliance would be valuable. Transport agencies,

> "…know that the more people they can move into walking and out of cars, the better the air quality. So, if you can find a way of making recommendations that satisfy the health goals, and also satisfy other goals that they have to reach, that makes a big difference." [research director].

Improved formats for presenting research data to decision makers was seen as a necessary step to engage transport agencies with health data. Brief reports and infographics, as opposed to more typical research data formats, could be more useful to transport professionals and decision makers and help spread information more widely. Relaying real-life examples and case studies that people connected to was important.

Many indicated the key to collaboration was having an interested academic; someone willing to invest time in relationship building. A planner stated,

> "it only really takes one or two professors or even PhD students to get interested to … make really fruitful collaborations."

Understanding each other's needs and goals was reported as key to developing a good working relationship. Some indicated that universities that do *not* have a city or urban planning department or school are actually more conducive to collaboration. Since faculty lacks transport expertise, they direct interested students to work with agencies. Developing a forum or committee of university researchers and AT practitioners was suggested as a way to facilitate collaboration. Several respondents suggested that having ongoing and regular meetings to develop a clear and unified purpose would be essential to co-designing better research.

> "I think just working together a little earlier in the process hopefully helps with that issue because you're not just being brought in as an afterthought." [manager information services].

4. Discussion

This study utilized rigorous qualitative methods to understand data use in AT planning and to explore the acceptability of PA research data sources and collaboration between academic researchers and transport agencies, with the goal of identifying facilitators of meaningful partnerships. Several themes emerged from the data that were mapped to the Knowledge and Persuasion stages of the Innovation - Decision Model. Related to prior conditions, the need for AT relevant data was evident, but the type and format of data varied by transport profession and planning stage. Participants reported dissatisfaction with current data sources, such as national surveys, and conveyed that research data that were current, local, objective, and specific to individual AT trips could enhance modeling and planning initiatives. GPS traces were especially advantageous as they provide objective route choice information on trips that are infrequent and often unreported in traditional travel surveys. The majority of responses focused on the need for cycling data, as it is even less common than walking. Comparisons between actual and alternative routes is also key in discovering what infrastructure is associated with increased demand (Dill and Toulan, 2009). The ability to quantify the benefits of AT infrastructure is critical to informing future investments, policies and priorities. Though not ideal, the small sample sizes typical in sensor based research studies were not deemed a significant barrier.

While planners and researchers agreed that data is important, how the data is presented can affect its impact. It has been shown that typical research presentation formats may not be persuasive to all planning audiences (Stamatakis et al., 2010). Brownson et al. suggested that research data must be relevant at the local level and communicated effectively to persuade policy makers who answer to the interests of numerous stakeholders (Brownson et al., 2006). GPS and PA data can be combined and presented in novel formats. For example, these data have been linked to create animated GPS traces that show, not only AT routes, but also the change in PA before and after built environment improvements. Animated GPS cycling routes can visually illustrate the proportion of a trip on high stress roads. We found these presentations facilitated a continued dialogue and discussion about concrete collaboration ideas that don't occur from a verbal description of the data alone. Many participants requested sample datasets or presentations to gauge the utility of the data, which raised the issue of data sharing and confidentiality. In human subjects research, participants consent to how their data can be used. Interview questions did not specifically probe this issue since the secondary use of research data for quality improvement activities is not considered human subjects research, thus may not require the same ethical oversight. It is interesting, however, that privacy concerns were not brought up by most interviewees. Though responsible for protecting personal information collected in travel surveys, MPOs generally must make data publicly available which may explain this perspective. However, location data, like GPS, are sensitive and thus confidentiality should be addressed. For data to be useful to transport agencies, procedures for easy and secure transfer of data are essential. Researchers should ensure that study consent forms provide the opportunity for participants to agree to sharing data for such uses and may need to provide training or guidance on data protection procedures when working with transport agencies.

Responses highlighted numerous forms of collaboration between PA researchers and transport professionals, with benefits and barriers to each. Though desirable, the expense of collecting and analyzing GPS data was a common concern. Academics that collect data within an MPO's jurisdiction for other research purposes could provide a more current, continuous and relevant data source for project planning and evaluation, to more effectively leverage limited financial and human resources. Additionally, the diversity of research study samples could provide data on groups that may be underrepresented in household travel surveys, and thus ensure that models are sensitive to different populations. Data from PA behavior change studies on environmental factors related to AT could inform project development to target barriers. MPOs may start to incorporate models to assess health impacts of transport plans, however agencies typically do not collect health data. PA, air pollution exposure, and health outcome data from research studies could inform these analyses. Researchers also have expertise in study sampling strategies and natural experiment design that could inform transport studies and help build scientifically valid evidence to support AT projects. Over time, collaboration could help alleviate the personnel, funding and administrative constraints faced by academics and AT practitioners alike if research questions of mutual benefit were identified and pursued jointly. Interestingly, the independence of researchers was viewed as both a benefit and a barrier. Research evidence may be perceived as “unbiased” by stakeholders, however this autonomy was challenging if research findings diverged from transportation agency priorities.

Another theme related to research translation between transport professionals, decision makers and researchers; a key challenge identified in a recent Lancet series on urban design, transport and health (Sallis et al., 2016). The findings from the present study support recent models outlining strategies to close this gap (Giles-Corti et al., 2015; U.S. Department of Transportation, 2012). The models highlight the need to identify a motivation, i.e. what gaps interdisciplinary collaboration could fill. The need for local and AT specific data may provide that initial motivation. However, a perceived disconnect between academic research and practical need was revealed. This likely stems from the limited opportunities for researchers and transport practitioners to intersect; they do not attend the same conferences, they publish in different outlets and have divergent professional growth paths. To create useful collaborations, researchers need to engage with transport professionals early and throughout the process to co-design research that is relevant and applicable to practitioners and decision-makers. The U.S. DOT report also points out that no formal requirements for the inclusion of PA or health in transport planning process exist and that regulations linked to funding may be necessary to make health outcomes a higher priority for MPOs (U.S. Department of Transportation, 2012). Given the limited time agencies have to devote to non-mandated efforts currently, the results of this study indicate that a highly-engaged academic may be critical in the initiation and success of these partnerships. Access to graduate students was reported as a major benefit of university collaboration. This approach could be particularly useful for understaffed agencies, until sufficient funding is designated to support these efforts or priorities are redefined (Meehan and Whitfield, 2017). Longer term capacity building was also identified as a key step. Otten et al. found that the lack of guidance, training and reward in academic promotion tracks were significant barriers to researchers engaging with policy makers and need to be addressed (Otten et al., 2015).

4.1. Limitations and strengths

Rigorous qualitative research methods were employed to ensure the reproducibility of the findings; however, this study is not without limitations. The use of a theoretical framework to guide data collection and analysis strengthened the study. A snowball sampling method was selected to recruit a sample with knowledge of research collaboration and transport data use, but the sampling of particular peer networks could over-represent certain practices or opinions. The sample size was small and the majority of respondents worked in large MPOs, which differ greatly in size and structure. Transport planning also occurs at the city, state and federal level; thus, results may not be generalizable. San Diego was a main focus of the paper and represented half the sample. As noted for context, significant collaboration hadn’t occurred despite the presence of PA researchers and a large MPO with experience including health in planning. Results presented may not apply to smaller regions. It is unknown whether collaboration would be more or less likely in regions with less transport or research funding and expertise. Collaboration might be more necessary in those regions, or increased resource constraints could further limit their capacity to work together. And while most large metropolitan areas have a university, this may not be the case for smaller regions and thus the opportunity to collaborate with local researchers may not exist. The decision to include interviewees from multiple regions in the U.S., as well as non-MPO roles, was a deliberate attempt to reduce this potential bias, however studies in more varied settings would provide context to these results. Future studies should also explore data sharing and confidentiality further to develop best practices.

4.2. Conclusions and recommendations

This study adds to the existing literature by providing empirical evidence of the benefits of PA researcher and transport agency collaboration and highlights the need for formalized systems to facilitate these collaborations. Based on the information provided by participants, some tentative recommendations are proposed, which may be useful in guiding both practice and research. The interviews served as a needs assessment, allowing both parties the opportunity to learn where needs align and may provide a model for other researchers to engage with transport agencies. Presenting research data in formats targeting specific phases of the planning process may facilitate data use. Systems to reduce the administrative burden of contracting agreements between agencies and universities, including procedures to ensure the ethical sharing of data, should be pursued to remove these barriers to collaboration. Participants overwhelmingly reported that project priority is based on federal requirements and regulations. Mandating the incorporation of health metrics in transport planning would contribute greatly to more closely aligning these fields and solving health and transport issues. Training programs that incorporate public health, planning, and modeling should be developed to encourage cross collaboration. Further, institutional support for researchers that pursue policy relevant research, like requiring community based partners, awarding research that contributes to a change in policy or practice, and training in communication strategies, should become standard at academic institutions (Sallis et al., 2016).

This study validates the acceptability of data driven collaboration by exploring previous practices and needs of transport agencies and the relative advantage and compatibility of PA data and research collaboration, in line with the early phases of the Innovation - Decision process. Future studies should assess the Implementation and Confirmation stages in agencies that have adopted research partnerships. The effect of incorporating research data on travel model performance, AT project perception, planning, and implementation and transport policies should be evaluated. Further, we know that “if you build it, they will come” is not sufficient to change behavior. Transport agencies may need to focus more on the promotion of completed projects and PA researchers’ expertise in behavior change could aid in increasing AT adoption to meet mode shift goals. Behavior change interventions should be designed in conjunction with AT infrastructure projects to maximize return on investment.

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Appendix A. Semi-structured interview protocol

Generic prompts: If responses are limited or require clarification, probes may be used to elicit more detailed responses. Probes should use words or phrases presented by the participant using one of the following formats:

- What do you mean by ________?
- Can you tell me more about ________?
- Can you give me an example of ________?

Topic	Questions
Introduction and Purpose	• Thank you for taking time to talk with me today. • I wanted to speak with you about your experience collaborating with academic or research groups on active transportation initiatives. • We are interested in how research data might be applied to active transportation modeling, planning or implementation. I’m interested in hearing your insight on: ▪ the planning, modeling and implementation process (who makes decisions, input and outputs?) ▪ data sources that are currently used and the degree to which this data meets your needs ▪ whether GPS, or other research data, would be useful in the modeling and planning process ▪ your academic/transportation collaboration experiences.
Verbal Consent	My name is Katie Crist, from UCSD’s Department of Family Medicine and Public Health, and am doing a research study, under the direction of Dr. Jacqueline Kerr. I am interested in learning more about research and planning related to active transportation. I’d like to ask you a few questions about the work that you do, which should take approximately 45 minutes. Your participation is voluntary and you may stop at any time. This interview will be audiotaped. Your responses will be kept confidential and neither you, nor anyone you mention in the interview, will be named in any presentations, reports or publications. The name of your organization will not be disclosed and will be referred to in general terms. You will be assigned an ID number and this interview will be stored by that number only on our secure server at UCSD. If you would like a copy of this letter for your records, I will email it to you. If you have any questions regarding your rights as a research subject you may call the Human Research Protections Program Office at 858-246-4777 or my advisor, Dr. Kerr, at 858-534-9305. • Do you have any questions before we start? • **START RECORDING**
Background Questions	• Can you tell me about your current position or role? (planning, modeling, policy?)

Main Questions	• What data do you currently use when working on a project about where to locate or what to propose? • How satisfied are you with the data you currently have? • Is there data that you don't currently have that would be helpful? What evidence do you need to do "X"? • Can you envision using the data we collect? a. Could GPS, physical activity demographic or built environment data be incorporated into your work? How easily? • What benefits or challenges might there be to using this type of data? • In what ways, if any, do you think partnering with researchers can support the work or contribute to AT modeling/planning or decision making? a. Are there research questions that would be useful to your work? • What challenges do you foresee collaborating with researchers? What benefits might there be? • Can you describe potential collaboration or ways that you would implement the data that would be useful? • How would you suggest approaching this type of collaboration? What would make it worthwhile to someone in your position or elsewhere? • Can you describe the collaboration with researchers that you've been a part of? a. Who was involved (types of people not names)? b. How often did you meet? c. What were the expectations of participation? d. What were the goals of the collaboration? Did you achieve them? e. Does the collaboration still exist? If not, why? f. Was there a contract? g. Funding? • How are decisions made? a. How much of a role do models play in the larger decision-making process about projects? b. What stage of the process do models factor in? c. What are the other factors? d. How do better models impact AT initiatives or plans? • How is health being considered in your work, if at all?
Follow up Questions	• Do you have any suggestions of example case studies or collaborations? • Is there anyone else you would recommend that I contact?
Thank you	• Thank you for your time! • Do you have any questions?

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