It's how you say it - The extended Theory of Planned Behaviour explains active transport use in cardiac patients depending on the type of self-report in a hypothesis-generating study

Peer-reviewed author version

BATOOL, Tooba; ROSS, Veerle; BRIJS, Kris; NEVEN, An; Smeets, Christophe J. P.; SCHERRENBERG, Martijn; DENDALE, Paul; VANROMPAY, Yves; JANSSENS, Davy & WETS, Geert (2022) It's how you say it - The extended Theory of Planned Behaviour explains active transport use in cardiac patients depending on the type of self-report in a hypothesis-generating study. In: Transportation Research Part F: Traffic Psychology and Behaviour, 90 , p. 120 -135.

DOI: 10.1016/j.trf.2022.08.005
Handle: http://hdl.handle.net/1942/38727

It’s how you say it – the extended Theory of Planned Behaviour explains active transport use in cardiac patients depending on the type of self-report in a hypothesis-generating study

Tooba Batool[a1], Veerle Ross[a], Kris Brijs[a], An Neven[a], Christophe JP Smeets[b], Martijn Scherrenberg[c, d], Paul Dendale[c, d], Yves Vanrompay[a], Davy Janssens[a], Geert Wets[a]

[a]*UHasselt - Hasselt University, Transportation Research Institute (IMOB), Agoralaan, 3590 Diepenbeek, Belgium*

[b]*Ziekenhuis Oost-Limburg, Future Health department, Schiepse Bos 6, 3600 Genk, Belgium*

[c] *Department of Cardiology, Jessa Hospital, Stadsomvaart 11, 3500 Hasselt, Belgium*

[d]*UHasselt, Faculty of Medicine and Life Sciences, Agoralaan 3590, Diepenbeek, Belgium*

---

[1]Tooba Batool. Tel.: +32 (0) 11 26 91 11; fax: +32 (0) 11 26 91 99.

E-mail address: tooba.batool@uhasselt.be, Secondary e-mail: tooba.moosa90@gmail.com

Conflict of interest

All authors declare no conflict of interests.

Role of the funding source

The PhD. student conducting the presented research was supported by the Higher Education Commission, Pakistan (3 years) and the Special Research Fund (BOF) of Hasselt University (14 months). The funding sources had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Author contributions

Tooba Batool: Writing **-** original draft, conceptualization, methodology, software, investigation, formal analysis, data curation, visualization, project administration, **Veerle Ross:** conceptualization, methodology, validation, resources, writing **-** review & editing, supervision, **Kris Brijs:** conceptualization, validation, resources, writing **-** review & editing, supervision, **An Neven,** investigation, resources, writing **-** review & editing, supervision, **Christophe Smeets,** investigation**,** resources, writing **-** review & editing, **Martijn Scherrenberg:** investigation, resources, writing **-** review & editing, **Yves Vanrompay:** investigation**,** resources, writing **-** review & editing, **Paul Dendale,** conceptualization, validation, resources, supervision, **Davy Janssens:** supervision, conceptualization, resources, funding acquisition, and **Geert Wets**: resources, supervision, funding acquisition

Abstract

Physical activity (PA) plays an essential part in the secondary prevention of persons with coronary heart disease (CHD). A substantial amount of PA can be gained through increasing the use of active transport modes (walking or cycling for at least 10 minutes/day) in CHD patients' daily routine, benefiting the mortality and morbidity rate as well as the environment. The current study aims to investigate the utility of the Theory of Planned Behaviour (TPB) framework extended with habit strength, in understanding the behavioural intention and the behaviour of using active transport modes during the daily travel routine of CHD patients. A cross-sectional survey was conducted from 131 CHD patients. The behaviour was measured using three self-report methods; 1) scale measure, the walking or cycling frequency, 2) direct ATS (Active Travel Score, PA calculated by the directly reported aggregated time spent per day for walking or cycling for travel purposes), and 3) indirect ATS (PA calculated by combining the duration spent on trips by walking and cycling from the self-reported one-day travel diary). Additionally, the participants completed surveys on the direct measures of TPB constructs and habit strength. The results indicated that the TPB constructs explained a 38% variance in the intention to use active transport modes of CHD patients, by which the variance increased to 59% with the addition of habit strength. On the contrary, different behavioural measures were explained differently by TPB and habit strength. The scale measure of behaviour was best predicted (up to 21%) by TPB and habit strength. However, the direct and indirect measures of behaviour were poorly explained (up to 3% and 10% only, respectively). Habit strength moderated the relationship between behaviour (scale measure) and behavioural intention. Surprisingly, higher behavioural intention resulted in a lower behavioural frequency when the habit strength to be active is low. This suggests a limited control over the behaviour thus indicating the intention-behaviour gap. The current study findings highlight the inconsistent predictive utility of TPB across different types of behavioural self-report measures, targeted at the use of active transport modes in CHD patients. However, considering this study as hypothesis-generating, further research is necessary to replicate and extend these findings.

Keywords: Active transportation, Theory of Planned Behaviour, habit strength, travel behaviour, coronary heart disease, physical activity.

1 Introduction

1.1 Background

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) are the leading cause of mortality in the Western world as well as in developing countries. Yearly, almost 17.1 million deaths are due to CVDs (Gaze, 2013). Physical activity (PA) plays an effective role in managing CVDs, and in particular, coronary heart disease (CHD). Especially during rehabilitation and at primary and secondary prevention stages (Sallis, Floyd, Rodríguez, & Saelens, 2012), PA plays a pivotal role. Therefore, PA holds substantial potential for preventing new or recurrent events, reducing the progression of CVDs, improving the quality of life, and thus saving a significant amount of healthcare costs. To reduce the risk of non-adherence to the recommended level of PA, alternative opportunities to increase PA need to be identified. The guidelines for achieving the minimum PA level in the prevention of CVDs include i.e., 150 minutes per week of moderate-intensity PA or 75 minutes per week of vigorous-intensity PA (F Piepoli, 2017). A significant amount of PA can be achieved in the daily routine by using active transport modes. Various studies have shown the net health impact gain of active transportation through increasing PA levels (Brown, Moodie, Cobiac, Mantilla, & Carter, 2017; Zapata-Diomedi et al., 2017). Indeed, CHD patients can increase their PA during their travel routines by replacing short car trips with active transport modes (walking or cycling). Theory-based or non-theory-based behavioural interventions have been effective to promote PA in chronic diseases (Conn, Hafdahl, Moore, Nielsen, & Brown, 2009; Gourlan et al., 2016; Greaves et al., 2011). However, studies designated to enhance and assess the impacts of travel-related PA in primary and, in particular, secondary preventions, are rare. Importantly, before being able to design interventions to enhance the use of active transport modes (e.g. in the daily routines of patients with CVDs), it is essential to understand the underlying psychological determinants of the behaviour. The utility of the Theory of Planned Behaviour (TPB) is observed in explaining a wide range of health-influencing behaviours such as smoking, binge drinking, maintenance of PA, condom use, adherence to medication or treatments, etc. (Albarracín, Kumkale & Johnson, 2004; Armitage, 2005; Guénette et al., 2016; Lin, Updegraff & Pakpour, 2016; Lockyer, 2001; Norman, Armitage & Quigley, 2007; Norman, Conner & Bell, 1999). This study aims to explore the utility of the extended TPB (eTPB) to explain the daily use of active transport modes in CHD patients as a way to increase the PA level, utilizing three types of self-reported behavioural measures.

1.2 Definition and utility of Theory of Planned Behaviour

The TPB is considered as one of the most influential conceptual frameworks to explain human behaviour, due to its utility to understand and predict a wide range of social behaviours (Ajzen, 2011). It also provides a theory-based framework to design interventions to change unhealthy behaviours (Hardeman et al., 2002). The TPB states that the intention to perform a behaviour is fairly predicted from three constructs; i.e., attitude towards the behaviour, Social Norms (SN), and Perceived Behavioural Control (PBC). These three constructs that guide human behaviour are further explained as 1) beliefs associated with likely good or bad consequences (behavioural beliefs) of performing the target behaviour; 2) beliefs associated with normative expectation (normative beliefs) of other people towards that action, and 3) the perception of existing factors (control beliefs) which may advance or hinder the performance of the behaviour. After behaviour attains sufficient control and an intention is formed, by which people will carry out their intention as soon as an opportunity arises. This way, an intention is considered as a precursor of the behaviour. In general, many behaviours are difficult to perform because of the limited volitional control. Therefore, PBC serves as a proxy to the actual control and contributes directly to the prediction of the target behaviour (Ajzen, 1991, 2002b, 2011). The gap between the intentions and actual action might be reduced once an individual is asked to formulate a plan for regulating the behaviour (Ajzen, Czasch, & Flood, 2009; Bird, Panter, Baker, Jones, & Ogilvie, 2018; Gollwitzer & Bargh, 1996). It is indicated from cumulative empirical evidence that SN, attitude and PBC account for 30-50% of the variance in intention. Additionally, behavioural intention and PBC together are accountable for 20-40% of the variance in the target behaviour (Ajzen, 1991; Armitage & Conner, 2001; Conner & Armitage, 1998; Elliott, Armitage, & Baughan, 2007).

The previous meta-analyses have indicated an important bias of the at-risk population on the TPB utility (Armitage & Conner, 2001; Hardeman, Kinmonth, Michie, & Sutton, 2011; Rich, Brandes, Mullan, & Hagger, 2015). The majority of studies in the literature are conducted with students and healthy populations. Therefore, the need to conduct studies with populations at risk (e.g., CHD patients) is highlighted in various studies (Akbar, Anderson, & Gallegos, 2015; Armitage & Conner, 2001; Hardeman et al., 2011). It is usually observed that while predicting behaviours such as walking and attaining PA, the objective measures of behaviour are less predictable than self-reported measures (Plotnikoff, Courneya, Trinh, Karunamuni, & Sigal, 2008; Scott, Eves, French, & Hoppé, 2007). Likewise, different types of behavioural measures also vary in the degree of their variance explained by the TPB. For example, one study explored two different types of measuring speeding behaviour; firstly, a self-reported measure to avoid speeding, and secondly, an observed measure to avoid speeding which was measured by a simulator. The TPB measures explained the variance in the self-reported measure as 67%, while in the observed measure, a 31-39% variance was explained (Elliott et al., 2007). Similarly, another study used a direct measure of behaviour, in which they directly asked the average days and time spent (minutes) in a week on cycling for transport purposes. In this study, TPB measures predicted 26% of the variance in cycle use. In another study, a self-reported car commute from a travel diary of the previous week was used (Kerr, Lennon, & Watson, 2010). The measures of the TPB framework explained a 52% variance in the car commute behaviour. However, the majority of studies usually used single behaviour measurements, especially in mode choice related behaviours (Gert Jan de Bruijn, Kremers, Singh, Putte, & van Mechelen, 2009; Donald, Cooper, & Conchie, 2014; Lizana, Tudela, & Tapia, 2021; Murtagh, Rowe, Elliott, McMinn, & Nelson, 2012).

To the best of our knowledge, the studies comparing the predictability of different types of behaviour measures by the TPB framework, are rare (Scott et al., 2007). The insight into the degree of congruence across different types of self-reported behaviour measures will add to the limited understanding of behaviour predicted by TPB. For example, this will enhance our understanding of the motivational tendencies in the actual behaviour measure, compared to the measure which is explicitly compatible with its psychological precursors. As already mentioned, the comparison of objective and self-reported measures is only present to a limited level in previous studies. However, the understanding of a compatible scale measure of behaviour with more implicit and representative behavioural measures still needs to be explored to test the utility of TPB across these measures.

1.3 Habit strength

Habitual behaviour refers to the automatic activation of behavioural responses (Aarts & Dijksterhuis, 2000a). However, the TPB considers the actions as a consequence of a reasoned process and deliberated control. Habit is defined as learned behavioural sequences, which have become automatic under stable contexts and are functional in order to achieve certain goals and end states (Bas Verplanken, 2006; Bas Verplanken & Aarts, 1999). If the same behavioural choices are repeated under similar environmental cues, an association to these contextual cues builds up, which provides a satisfactory experience to the individual. This in consequence leads to automaticity of the behaviour. "Automaticity" is characterized as a lack of awareness, control and intention, while adding efficiency to the task (Lally, Van Jaarsveld, Potts, & Wardle, 2010; Robert S. Wyer, Srull, & Srull, 2014; B. Verplanken, Myrbakk, & Rudi, 2005).

Due to the limited variance explained by the TPB in the behaviour, previous studies often have extended the TPB framework by adding relevant constructs to explain the behaviour better. For example, past behaviour and self-identity significantly improved the behaviour prediction along with the TPB (Gert Jan de Bruijn, Verkooijen, Vries, & Putte, 2012; Sommer, 2011). The main reason to include habit strength in the TPB framework is related to its important contribution to behavioural prediction. According to the recent developments in habit psychology, habit is considered one of the important mechanisms that guide human actions. Habit is related to actions or behaviour through two different paths, as advocated in dual-process theories of behaviour (Gardner, De Bruijn, & Lally, 2011; Bas Verplanken, 2018). According to dual-process approaches, a behaviour is elicited through two pathways: the first is the deliberated route which involves cognitive thought processes, and the second is automatic, which is triggered by environmental cues (Gardner et al., 2011). To explain further, in stable contexts, the habit will predict the behaviour and weaken the intention-behaviour link (Gardner; Triandis, 1977). As habit strength grows, the behavioural control is shifted to environmental stimuli, and reliance on deliberation/motivational processes subsides (Gardner). Therefore, habit strength is considered as an alternative pathway towards behaviour and/or intention (Donald et al., 2014). This also relates to the traditional behaviourist point of view which says that under the stable environmental cues and through positive learned responses (e.g., daily commute by car or active transport mode), the behaviour performance becomes automatic with nominal forethought (Gardner; Bas Verplanken, Aarts, Van Knippenberg, & Moonen, 1998; Bas Verplanken, Walker, Davis, & Jurasek, 2008; Bas Verplanken & Knippenberg, 1996). At this stage, if the salient information regarding the alternatives is provided, it will more likely be ignored (Aarts & Dijksterhuis, 2000a; Aarts, Verplanken, & Knippenberg, 1998). However, at the same time, habit is also a goal-directed construct that refers to the fact that if a new context arises (e.g., changing the office location to another city) or the habits are disrupted, then the deliberated decision making is renegotiated. For example, the repeated frequency of car commute becomes a scripted choice (triggered through environmental cues) and the deliberate cognitive processing will not be required unless a new context arises, e.g., relocation of the workplace (Donald et al., 2014; Friedrichsmeier, Matthies, & Klöckner, 2013; Nordfjærn, Şimşekoılu, & Rundmo, 2014). Transport mode choice behaviour is characterized by a repetitive nature, meaning that it tends to become habitual, e.g., daily use of the same transport mode for the commute (Fu, 2020; Bas Verplanken et al., 1998). Various studies have shown that the habitual use of certain transport modes predicts the behaviour over and above the reasoned decision making of choosing that transport mode (Bamberg & Schmidt, 2003; Brug, Vet, Nooijer, & Verplanken, 2006; Gert Jan de Bruijn et al., 2009; Bas Verplanken et al., 1998). Accordingly, adding habit strength to the TPB will further confirm the dual function of habit strength in determining the use of active transport modes in an at-risk population. For example, strong habits regarding the mode choice (i.e., use of active transport modes) would predict the behaviour significantly and would make the influence of deliberation or intention weak on eliciting the behaviour (Fu, 2020; Gardner, 2009; Bas Verplanken & Aarts, 1999).

1.4 Study objectives

The current study compares the predictability of three different types of self-reported measures by the TPB framework and habit strength. These measurement methods vary from a scale measure of behavioural frequency to an implicit The current study is hypothesis-generating as it explores the psychosocial influences of the use of active transport modes of CHD patients for the first time. indirect measure of behaviour. Moreover, part of the primary aim includes empirically testing the utility of the rational (TPB) and habitual (habit strength) influences in explaining the intention as well as the use of active transport modes for daily travel purposes of CHD patients. The principal assumptions of the TPB to explain the active transport use of CHD patients and the moderating role of habit strength in rational decision-making are stated below:

- Attitude, PBC, and SN positively relate to the intention to use active transport modes (H_1, H_2, H_3)
- The intention along with its correlates positively relates to the use of active transport modes (H_4).
- PBC contributes directly to explain the use of active transport modes (H_5).
- Habit strength adds collective and an independent effect in explaining the intention and use of active transport modes use (H_6, H_7)
- Habit strength moderates the relationship between intention and use of active transport modes (H_8).

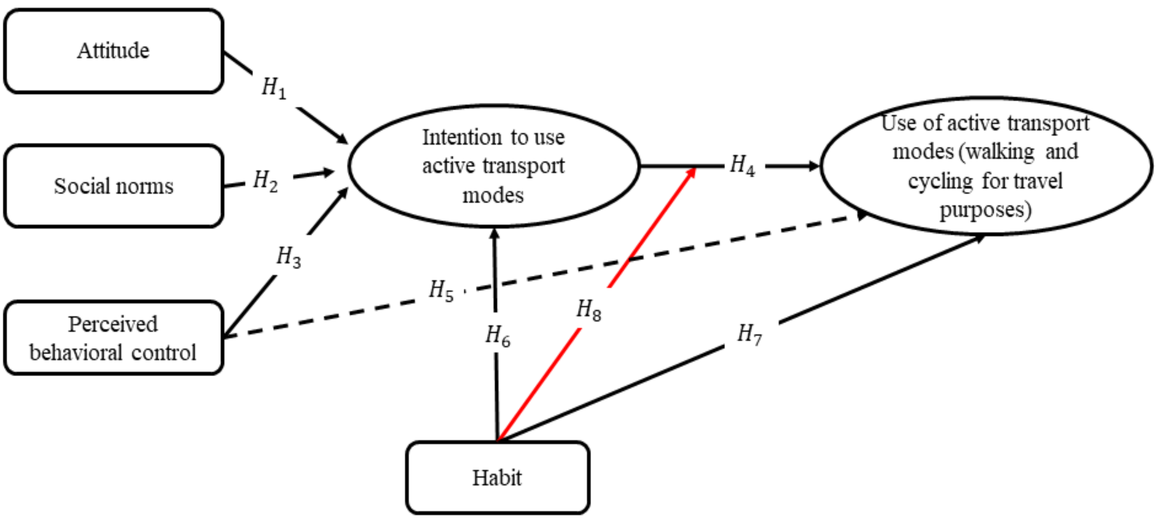

Figure 1 Hypothesized working model of the study (extended TPB model), red dotted line presents the hypothesis of moderating relationship

2 Methods

2.1 Design

The survey on the TPB constructs and habit strength was conducted as part of a larger study in which travel behaviour data of CHD patients was collected using self-reported travel diaries and a smartphone application (Batool, Vanrompay, Neven, Janssens, & Wets, 2018). To assess psychological constructs related to the use of active transport modes (TPB constructs and habit strength), together with the daily travel behaviour patterns of CHD patients, the study included the following questionnaires:

1. Personal information: socio-demographic (e.g., age, educational level, gender, and household information (e.g., household size, net income)).

2. One-day travel diary (an indirect behavioural measure): information of a sequence of travel activities in time (when) and space (where), including the purpose of the movement, the transport modes used, and travel partner(s)
3. Attitude and behaviour towards active transport survey: TPB, habit strength and two measures of behaviour (scale and direct measures)

The study, conducted in 2018 and 2019, consisted of two phases (phase I and II). After approval (B243201834882) by three ethical committees (Hasselt University (Hasselt, Belgium), Jessa Hospital (Hasselt, Belgium) and Ziekenhuis Oost-Limburg (ZOL, Genk, Belgium), in phase I, the questionnaires were sent by post to 550 randomly selected patients meeting the inclusion criteria (Batool, Neven, Scherrenberg, et al., 2021). After signing the informed consent, the patients were asked to fill out the questionnaires and the one-day travel diary, and send it back to the research institute. The day on the travel diary that should be filled by the patient, was specified randomly by the research team, to get an equal distribution of all days in the week. The participants were advised in the instructions that the reported day should be representative of their routine travel behaviour. The definition of the use of active transport modes was defined clearly in the questionnaires and particularly highlighted before the start of the attitude and behaviour questionnaire, to clarify the behavioural term according to the Target, Action, Context, and Time (TACT) principle (Ajzen, 2002a). If the returning post was not received back in 3 weeks, a follow-up telephone call was made to non-respondents. A few willing respondents asked for the questionnaire to be sent again and the rest refused to take part in the study.

The questionnaire including the TPB, habit strength and measures of behaviour (scale and direct measures), was also filled out by a group of CHD patients in phase II of the study. During this phase, CHD patients received recruitment flyers in a rehabilitation centre to participate in an ongoing study targeting their travel-related PA. Interested patients had to confirm to meet the in- and exclusion criteria (Batool, Neven, Smeets, et al., 2021) and to indicate their preference for attending a preparatory work session. In that work session, the use of a smartphone app was explained (developed to monitor the travel behaviour objectively) and patients were asked to fill in the same questionnaires similar to the ones used in phase I. The monitoring of the travel behaviour patterns in the second phase was done through a smartphone app, which is an objective measure. The self-reported travel diary (as used in phase I) was therefore not used anymore in the second phase. The sample size of the participants using only the smartphone app was limited, and therefore, the results related to this objective measure of behaviour in phase II are beyond the scope of the current study. These are discussed in a separate paper, submitted for publication (Batool, Neven, Smeets, et al., 2021). In the current study, the data of CHD patients of two phases I & II, related to TPB and habit constructs, as well as the self-reported measures of active travel behaviour, was included.

2.2 Measures

2.2.1 Theory of Planned Behaviour constructs

The TPB questionnaire was prepared considering the manual for “Constructing a TPB Questionnaire: Conceptual and Methodological Considerations” by Icek Ajzen (revised 2006) and translated in Dutch. The target behaviour was defined considering the TACT principle (Ajzen, 2002a) as *using active transport (walking or cycling for at least 10 minutes/day) modes daily for travel purposes*. The TPB constructs intention, attitude, social norms and PBC were measured using direct standard scaling procedures. A seven-point Likert scale was used, ranging from 1 (extremely agree) to 7 (extremely disagree). Three items measured the intention of the behaviour, 1) *I expect to use active transport (walking or cycling for at least 10 minutes/day) modes daily for travel purposes* 2) *I intend to use…* 3) *I try to use...* To measure attitude, seven evaluative bipolar adjectives were used. Four item pairs were instrumental in nature (*advantageous-disadvantageous, reliable-unreliable, cost-efficient-not cost-efficient, environment friendly-non-environmental friendly*), while three item pairs were experiential in nature (*pleasant-unpleasant, convenient-inconvenient, time taking-less time taking*). The positive and negative endpoints of the attitude items were counterbalanced to control for the alertness of the responses.

To measure the SN, three items of an injective nature were used, 1) *it is expected of me to use active* *transport (walking or cycling for at least 10 minutes/day) modes daily for travel purposes*, 2) *Most people important to me think that I should …* 3) *The people in my life whose opinion I value approve that using … is good for me*. Furthermore, three items of SN were of a descriptive nature 1) *My doctor advise that using active transport (walking or cycling for at least 10 minutes/day) modes daily for travel purposes is good* 2) *The people in my life whose opinion I value use …* 3) *People with heart disease like me use….* Six items were designed to capture PBC, distinguishing between capability and controllability of the behaviour. The capability to perform the behaviour was measured by two items, 1) *It is difficult for me to use active transport (walking or cycling for at least 10 minutes/day) modes daily for travel purposes* 2*) I think I have complete control over using….* To measure control/self-confidence, three items were asked 1) *If I want I can use active transport (walking or cycling for at least 10 minutes/day) modes daily for travel purposes* 2) *If I plan, I can…* 3) *It is entirely up to me to use … or not*.

2.2.2 Habit strength

We used a standard scale measure called the Self-Report Habit Index (SRHI), which measures the perception of repetition, automaticity, and self-identification with behaviour as important characteristics of habit strength. This measure was developed by Verplanken and Orbell (2003) to overcome the criticism of previous habit assessment tools that were mainly based on past behaviour frequency only (Bas Verplanken, 2018; Bas Verplanken & Orbell, 2003). The SRHI is a frequently used tool to measure habit strength (Bas Verplanken & Orbell, 2019) and has already been implemented in behaviour related to PA (Gardner et al., 2011) and active transportation (Gert Jan de Bruijn et al., 2009). To measure the habit strength, a short form of the SRHI was used, capturing all three facets of habit which were identified by Verplanken and Orbell (2003) (Gardner & Tang, 2014): performance frequency (i.e., *I regularly use active transport modes (i.e., walking or cycling for at least 10 minutes/day) for travel purpose* and *using … belongs to my routine*), automaticity (i.e., *I do without thinking…*, and *It is weird if I do not use …*) and self-identity (i.e., *using… that's typically me*). It also included the common experiences of automaticity such as uncontrollability (i.e., *It is hard for me not to use …*). Keeping all three facets provides the opportunity to represent the proposed characteristics of habit from its definition (Gardner, Abraham, Lally, & de Bruijn, 2012). Moreover, various subscales of the SRHI have been used without a loss of reliability of the measure (Gardner, 2009; Gardner et al., 2012; Honkanen, Olsen, & Verplanken, 2005; Rhodes & Bruijn, 2010), thus confirming the redundancy in items. Therefore, six out of twelve items were kept to balance the questionnaire length. For example, the study by Honkanen, Olsen, & Verplanken (2005) which used the subscale of the SRHI, consisted of four items representing different facets of habit as used in the current study. This study found good composite reliability between these items (Honkanen et al., 2005).

2.2.3 Behavioural measures

The first behavioural measure used was a single **scale measure** of the frequency of active transport use. It was developed to be compatible with the psychological precursors (TPB constructs) as required by the TPB manual (Ajzen, 2002a). The questions asked to report on the scale measure of the behavioural frequency of walking and cycling, were designed on a seven-item Likert scale, i.e., "*How often you have walked (for at least 10 minutes) for travel purposes during the last 3 weeks"* and the responses were formulated as *1) every day, 2) almost every day, … 7) never.* To use as a combined measure of active transport, a new variable was created, i.e. the scale measure of use of active transport frequency **(SM)**, which included the multiplication of walking and cycling scale measurement responses.

PA is defined as a bodily movement resulting in Energy Expenditure (EE) (de Almeida Mendes et al., 2018). This EE is defined in Metabolic Equivalent (MET) (Ainsworth et al., 2011), which means the amount of oxygen consumed during rest position is 3.5 ml of oxygen per body weight (kg) per minute (Jetté, Sidney, & Blümchen, 1990). 1 MET equals to 1 kcal per body weight per hour (Ainsworth et al., 2011). Active transport use which is represented by the PA level gained by walking and cycling trips was assessed in two different self-reported manners (direct and indirect). For both direct and indirect measures of behaviour in the current study, the duration spent on the active transport modes was converted to the PA level to have the same unit of energy expenditure as kcal/kg*day. A scoring system, i.e., the Active Travel Score (ATS), was used (Batool, Knapen, et al., 2018), based on the aggregation of PA gained by active transport modes used in the patient's travel patterns. First, a direct self-report measure, **direct ATS,** was calculated based on the response to two questions that directly queried the performance of the target behaviour. The respondents were asked to report the average minutes spent on 1) walking trips for travel purposes per day and 2) cycling trips for travel purposes per day. An example of the question formulation for asking the direct measure (direct ATS) is: *How many minutes/day have you walked for travel purposes during the last 3 weeks?* In the second line, respondents were asked about the average/day minutes spent on walking during the travel. The participant's minutes of walking per day were multiplied by the standard MET (Ainsworth et al., 2011) value of 3.5 kcal/kg*h in case of walking, and of 7.5 kcal/kg*h for cycling. Then, this score was summed to get the direct ATS. Higher values of ATS correspond to higher levels of travel-related PA achieved.

Secondly, an indirect self-reported measure, **indirect ATS**, was calculated by summarizing the walking and cycling trips from the one-day travel behaviour diary and then calculating the corresponding PA level or ATS. To calculate the indirect ATS, the frequency and duration of the walking and cycling trips were first identified from the travel diary data. Afterwards, the corresponding METs values (similar to as used in direct ATS) were multiplied with the frequency and duration of walking and cycling. Finally, the ATS of both active modes were summarised as it was done in the calculation of direct ATS. Both direct and indirect ATS were calculated considering the standard recommendations of 150 minutes/week of moderate-intensity PA or 75 minutes/week of vigorous-intensity PA (F Piepoli, 2017). These were converted into one-day recommendations, which means on average 21.4 and 10.7 minutes of walking and cycling respectively per day. The MET value for walking is considered moderate-intensity PA and that of cycling as vigorous-intensity PA. Both are equal to 1.3 kcal/kg*day or 1.3 ATS when multiplied by the standard corresponding time spent on walking and cycling.

2.3 Data analysis

At first, the Shapiro-Wilk statistic and Q-Q plots were used to check the normal distribution of intention, habit, PBC, SN, attitude, self-reported scale, and direct and indirect measures of behaviour. The data was analyzed using Studio Version 1.2.1335, 2009-2019 RStudio, Inc. At first, we used Explanatory Factor Analysis (EFA) to help identify the unobserved underlying factors from the observed indicators/items of the TPB survey. The measure of sampling adequacy was checked by the Kaiser-Meyer-Olkin (KMO) criterion, which detects common variance within the dataset. A value between 0.80-0.90 is considered meritorious or good. Bartlett's Test of Sphericity ($p \leq 0.000$) was also performed to check if the data was appropriate for performing EFA, and the significance of this test confirms to proceed (Costello & Osborne, 2005; Howard, 2016). To retain the factors, three criteria were checked, i.e., Kaiser criterion (eigenvalue > 1.0, Kaiser, 1960, 1970), scree plot, and parallel analysis (Costello & Osborne, 2005; Howard, 2016). Following the EFA analysis, Mcdonald's Omega (ω_h) and Spearman correlation tests were performed. Spearman's rank-order correlation was used to account for the non-normal distribution of the outcome variables. The significance of Spearman's Rho coefficient is judged using the guidelines in Psychology (Akoglu, 2018). The reliability of survey items to measure the one common factor (i.e., latent factor) was estimated using Mcdonald's Omega (ω_h). Mcdonald's Omega is considered the best estimate of reliability. Values above 0.65 are expected for ω_h, which refers to good reliability between survey items and indicates a classification error of <10% which is acceptable (Revelle & Zinbarg, 2008; Spearman, 2019). Two and three-step hierarchal multiple linear regression was used to determine the association of behavioural intention and behaviour to use active transport modes with the TPB constructs and habit strength respectively. The stepwise approach was used to see the additional variance before and after introducing the TPB constructs and habit strength in the model. For the three-step approach used for the behaviour, in the first step of the model, only TPB constructs (Attitude, PBC and SN) were entered. At the second stage, the behavioural intention was entered in the regression. Similarly, habit strength was entered in the third step. The test for multicollinearity was checked against the Variance Inflation Factor (VIF) criteria (VIF < 5) (Kim, 2019; Shrestha, 2020). Finally, a separate moderation and slope analysis was performed to test the interaction relationship between behavioural intention, habit, and behaviour. The independent variables were mean-centred before entering into the moderation analysis. An effective a-priori sample size calculation was made using the borderline prediction power of the TPB from the literature (Armitage & Conner, 2001; Hagger, Chatzisarantis, & Biddle, 2002) to predict PA (R^2=0.20), with 5 degrees of freedom and 0.80 effect size or power, indicating the acceptable sample size as n = 51.

2.4 Participants

Out of the 550 envelopes that were sent in phase I, 84 (15.3%) were returned. In total, 131 (84 participants from phase I, and 47 participants from phase II) observations were used. The data included 85.5% (112) male participants, while gender information was missing for one participant. More than half, i.e., 51.1% (67), of the participants were in the age range of 40-65y and 45% in the range of 66-80y (59), while 3.8% (5) were older than 80 years, providing a mean age of 65.3 (±8.7). A study investigating the demographic and clinical characteristics of CHD patients in Western Europe and Spain indicated that the mean age was 65 and 81% of participants were male (Zamorano, García-Moll, Ferrari, & Greenlaw, 2014), which is in line with the sample presented in the current study. In addition, 22.9% (30) of the participants of the current study had a normal weight status and 77.1% (101) were overweight or obese. This percentage of overweight and obese patients is almost similar to what is observed for general CHD patients (up to 80%) (Ades & Savage, 2017). 66.4% of patients had no profession.

3 Results

3.1 Preliminary analysis

The EFA was used to extract the underlying TPB constructs from the set of 21 survey items. KMO = 0.85 and Bartlett's Test of Sphericity ($p < 0.000$) allowed to proceed for EFA. We used the *Oblimin* rotation method, which facilitates correlated items and is considered to perform satisfactorily (Costello & Osborne, 2005; Howard, 2016). A four-factor rotated solution was extracted based on Kaiser criterion, scree plot, and parallel analysis explaining 52% of the cumulative variance. The extracted factors were named as follows: PBC, attitude, intention, and SN. The higher factor loading values (association between survey item with the latent factor) refer to better association with underlying factors or latent factors. Different cut-off values for factor loadings are proposed, varying from 0.30-0.45. (Howard, 2016). Five items (Q15d, Q15dg Q17, Q20 and Q22) were removed due to shared factor loading and factor loading less than 0.35, as shown in Table 1.

Table 1 Exploratory Factor Analysis of TPB survey items

Survey items for TPB	Attitude	PBC	Intention	SN
Q11_ I expect to use …	0.063	0.025	**0.797**	0.016
Q12_ I intend to use …	-0.005	-0.028	**1.019**	-0.005
Q13_ I try to use …	-0.071	0.170	**0.669**	0.016
Q15a_ Advantageous-Disadvantageous	**0.684**	-0.180	0.066	0.214
Q15b_ Pleasant-Unpleasant	**0.660**	0.071	0.188	-0.020
Q15c_Reliable-Unreliable	**0.746**	0.116	-0.092	-0.014
Q15d_Cost efficient-Not cost efficient	**0.293**	-0.135	0.124	0.255
Q15e_Time taking-Less time taking	**0.589**	0.094	-0.071	-0.038
Q15f_ Convenient-Inconvenient	**0.649**	0.175	0.127	-0.153
Q15g_Environment friendly-non-Environmental friendly	**0.323**	-0.089	0.093	0.326
Q16_ Most people important to me think that I should use …	0.172	0.273	0.071	**0.386**
Q17_ It is expected of me to use …	0.061	0.338	0.071	0.264
Q18_ The people in my life whose opinion I value	-0.132	0.072	0.027	**0.785**

approve that using … is good for me				
Q19_ My doctor advise that using … is good	0.188	0.027	0.031	**0.615**
Q20_ The people in my life whose opinion I value use …	0.122	0.263	0.271	0.108
Q21_ The people with heart disease like me use …	0.069	0.307	0.045	**0.395**
Q23_ If I plan, I can use …	-0.031	**0.860**	0.062	0.077
Q24_ If I want I can use	0.025	**0.873**	0.042	-0.027
Q26_ It is entirely up to me to use …	0.219	**0.540**	-0.058	0.052
Q25_ I think I have complete control over using	0.118	**0.576**	0.076	0.062
Q22_ It is difficult for me to use …	0.266	0.123	-0.064	-0.069
Eigenvalues of extracted factors	3.05	3.18	2.71	1.95
Proportional variance	**0.15**	**0.15**	**0.13**	**0.09**

After removing the items that loaded poorly onto the factors, we calculated the mean and standard deviation for the TPB and habit constructs, as well as for the behaviour (SM, direct ATS, indirect ATS), together with the Spearman's correlation between them (Table 2). The McDonald's Omega (ω_h) was also calculated and the values attained for our latent factors were in the acceptable range (Table 2).

The important observation from Table 2 can be noted that the intention was significantly correlated with its constructs (i.e., PBC, attitude and SN). A strong positive inter-correlation (zero-order correlation) was found between intention and PBC ($r_s = 0.64$, $p = <0.01$). However, it has a moderately positive correlation with SN and attitude. The intention was strongly correlated to habit strength as well (Spearman's Rho range, $r_s = 0.74$, $p < 0.01$). Likewise, behavioural intention is moderately correlated with all three behaviour measures, scale measure (SM), direct ATS and indirect ATS (Spearman's Rho range, $r_s = 0.41$-0.46, $p < 0.01$). Moreover, all three behaviour measures are also correlated individually with all three constructs of TPB and habit strength as shown in Table 2. Therefore, simple correlation analysis supports the hypotheses (H_1-H_7).

Table 2 Bivariate Spearman correlation between TPB constructs and behaviour

		N	Mean	SD	ω_h	1	2	3	4	5	6	7	8
1	Intention	123	5.1	1.6	0.84	1							
2	Attitude	113	5.1	1.4	0.75	0.49^{**}	1						
3	SN	125	5.7	1.1	0.73	0.5^{**}	0.45^{**}	1					
4	PBC	125	5.3	1.5	0.85	0.64^{**}	0.54^{**}	0.54^{**}	1				
5	Habit	122	4.5	1.6	0.86	0.74^{**}	0.49^{**}	0.43^{**}	0.53^{**}	1			
6	SM	130	15.1	14.0	-	0.46^{**}	0.37^{**}	0.36^{**}	0.40^{**}	0.54^{**}	1		
7	Direct ATS	122	8.5	18.9	-	0.42^{**}	0.30^{**}	0.34^{**}	0.29^{**}	0.49^{**}	0.58^{**}	1	
8	Indirect ATS	68	4.99	8.7	-	0.41^{**}	0.44^{**}	0.39^{**}	0.38^{**}	0.32^{*}	0.48^{**}	0.38^{**}	1

ω_h = McDonald's Omega, p < 0.000**, p < = 0.01*

3.2 Prediction of behavioural intention and use of active transport modes

The first step of hierarchal multiple linear regression analysis indicated that all three precedents of intention were significant. This model explained a 38% variance in behavioural intention to use transport modes. When habit strength of using active transport modes (walking cycling for at least 10 minutes/day) was added in step 2, the model accounted for an additional 21% variance in explaining behavioural intention. Habit strength and PBC were the significant predictors for intention to use active transport modes. Therefore, from our first model, it is concluded that the intention to use active transport modes is fairly well predicted by PBC, SN, attitude, and habit strength; confirming our hypotheses (H_1, H_2, H_3, H_6).

Table 3 Two-step hierarchal regression outcome explaining behavioural intention (model 1)

Behavioural intention	PBC	Attitude	SN	Habit	Adj. R^2	ΔR^2	F-value for ΔR^2
1 (β_1)	0.43^{***}	0.18^{-}	0.31^{**}	-	**0.38**		
(β_2)	0.39	0.16	0.20	-			
2 (β_1)	0.22^{**}	0.05	0.16	0.57^{***}	**0.59**	0.21	56.47^{***}
(β_2)	0.20	0.04	0.09	0.57			

β_1 = unstandardized coefficient, β_2 = standardized coefficient
$p < 0.1$ = -, $p < 0.05$ = *, $p < 0.01$ =**, $p < 0.001$ = ***
F-value for overall models,
F-value (step-1)= 23.33^{***}
F-value (step-2)= 40.96^{***}

The second model followed the three-step approach of hierarchal multiple linear regression. First, introducing the TPB constructs to assess the level of association with the scale measure of behaviour (SM), the result showed that the attitude and PBC were significant factors. The addition of intention to its related constructs resulted in a slight increase in overall variance. However, adding habit strength in the third step increased the overall variance explained to 21%. Therefore, the hypothesis (H_4) that intention and TPB constructs contributed to explaining the behaviour, were supported in the case of scale measure of use of active transport frequency (SM). The hypothesis (H_5) that the PBC significantly contributes to the prediction of behaviour, was only true in the case of scale measure (SM). The habit strength also significantly predicted the behaviour (H_7), as mentioned in Table 4.

In our third model, the direct measure of behaviour (direct ATS) was regressed with TPB and habit strength. The result of the first step of the model showed that none of the TPB constructs contributed to explaining the direct measure of behaviour (direct ATS) and the overall model fit was also poor. The first two steps of the third model explained only 1% variance in the behaviour. In the third step, when habit strength was introduced, the explained variance was increased by 2%. Habit strength was the only significant ($p = 0.08$) construct in explaining the direct measure of behaviour (direct ATS). Therefore, in explaining the direct measure (direct ATS) of the use of active transport modes for travel purposes, hypothesis (H_7) was supported that the habit strength significantly contributed. The hypotheses (H_4, H_5) were rejected as TPB constructs and intention poorly predicted the behaviour.

To predict the indirect behaviour (indirect ATS) in our fourth model, in the first and second step, from the behavioural intention and TPB constructs, none was significant. However, the overall variance explained was 10% by intention and TPB constructs. The addition of the habit strength in the third step did not change the explained variance (Table 4). Therefore, the hypothesis (H_4) was partially supported as the intention was not a significant predictor but still it contributed to explaining the behaviour. The hypothesis (H_7) that the habit strength significantly predicted the indirect behaviour, was rejected.

Interestingly, when predicting intention, adding habit strength to the TBP constructs (model 1) changes the relative predictive strength of the TPB constructs (attitude, PBC and SN). Similarly, when predicting the behavioural measure SM, adding habit strength to both TBP constructs and intention changes the relative predictive strength of the measures (model 2). Also in both models 2 and 3, adding habit strength inverses (negative) the relationship of intention with behaviour. A variable changing the relationship of other predictors to the outcome variable is not uncommon in the case of a moderating effect (MacKinnon, Fairchild, & Fritz, 2007). The discussion related to this is not further elaborated as it does not contribute to the main study objectives. Overall, values in Table 4 show that PBC and habit strength are better predictors of behaviour (models 2 and 3) than intention.

Table 4 Three-step hierarchal regression outcome explaining scale measure of frequency (model 2) direct behaviour (model 3) and indirect behaviour (model 4)

		Intention	PBC	Attitude	SN	Habit	Adj. R^2	ΔR^2	F-value for ΔR^2
Model 2 (n = 106)									
SM	1 (β_1)	-	2.36^{*}	1.90^{-}	-0.13	-	0.11		
	(β_2)		0.24	0.18	-0.01				
	2 (β_1)	1.49	1.72	1.63	-0.59	-	0.12	**0.01**	2.02^{ns}
	(β_2)	0.16	0.17	0.16	-0.04				
	3 (β_1)	-1.15	1.25	1.14	-0.95	4.32^{***}	0.21	**0.09**	13.37^{***}
	(β_2)	-0.13	0.13	0.11	-0.07	0.48			
Overall F-values of each step in Model 2, F-value (step-1) = 5.40^{***}, F-value (step-2) = 4.59^{***}, F-value (step-3) = 6.78^{***}									
Model 3 (n=100)									
Direct ATS	1(β_1)	-	-1.42	1.23	3.96	-	0.01		
	(β_2)	-	-0.11	0.09	0.19	-			
	2(β_1)	1.65	-2.19	0.90	3.74	-	0.01	**0.00**	1.22^{ns}
	(β_2)	0.13	-0.17	0.07	0.18				
	3(β_1)	-0.19	-2.53	0.56	3.36	3.05^{-}	0.03	**0.02**	3.14^{-}
	(β_2)	-0.02	-0.19	0.04	0.16	0.26			
Overall F-values of each step in Model 3, F-value (step-1) = 1.37^{ns}, F-value (step-2) = 1.33^{ns}, F-value (step-3) = 1.72^{ns}									
Model 4 (n = 51)									
Indirect ATS	1(β_1)	-	1.16	0.88	1.30	-	0.09		
	(β_2)		0.20	0.11	0.16				
	2(β_1)	0.97	0.71	0.48	0.97	-	0.10	**0.01**	1.14^{ns}
	(β_2)	0.19	0.12	0.06	0.12				
	3(β_1)	1.79	0.78	0.67	0.95	-1.19	0.10	**0.00**	0.94^{ns}
	(β_2)	0.36	0.13	0.08	0.12	-0.22			
Overall F-values of each step in Model 4, F-value (step-1) = 2.91^{*}, F-value (step-2) = 2.47^{-}, F-value (step-3) = 2.16^{-}									
β1 = unstandardized coefficient, β2 = standardized coefficient p < 0.1 = -, p <0.05 = *, p < 0.01 =**, p < 0.001 = ***, ns = not significant									

3.3 Moderation effect of habit strength

The moderation analysis was performed to check the moderating effect of habit strength between all three measures of behaviour and intention (H_8). The interaction effects between habit strength and behavioural intention were not significant in explaining the direct measure of behaviour (direct ATS) ($\beta_{habit*intention}$ = 0.07, $p >$ 0.05) and the indirect measure of behaviour (indirect ATS) ($\beta_{habit*intention}$ = 0.14, $p >$0.1). Therefore, hypothesis H_8 is not supported as habit did not moderate the relationship between behavioural intention and direct and indirect measurement of the use of transport modes. However, the habit strength moderated the relationship between behavioural intention and the scale measure of behaviour (SM), ($\beta_{habit*intention}$ = 1.41, p < 0.01), Therefore, hypothesis H_8 is supported, and habit significantly moderated the relationship between behavioural intention and the scale measure of behaviour (SM). Additional slope analysis confirmed that intention was a significant predictor (continuous line) of the behaviour (SM) at low levels of habit strength (Figure 3). The continuous green line in Figure 3 represents the significant slope at low levels of habit strength ($\beta =$

$-2.18, p < 0.1$). This means that for those who have low habit strength (for being active), the intention has a negative influence on activity: the more they intend to be active, the less likely they are to be active. For the respondents scoring higher on intention, lower behaviour patterns were observed. However, for the respondents having high habit strength (for being active), intention makes little difference in their activity (SM), ($\beta = 2.34, p > 0.1$). This slope where the respondents' intentions were found insignificant when the habits to use active transport modes were already strong, has been observed in previous studies (Brug, de Vet, de Nooijer, & Verplanken, 2006; Gert Jan de Bruijn et al., 2009; Bas Verplanken et al., 1998).

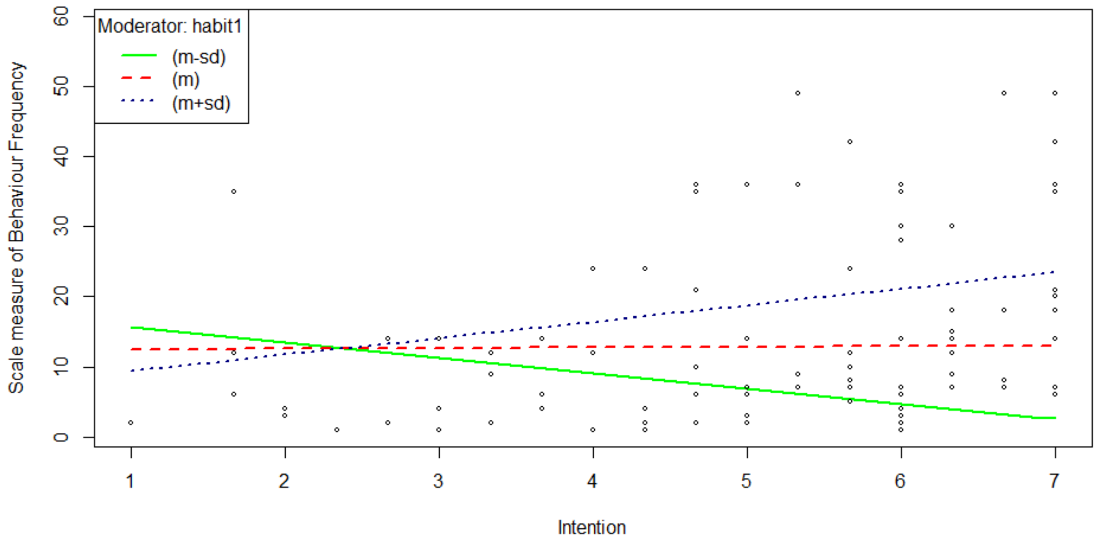

Figure 2 Decomposition of interaction between intention and habit strength to moderate the behaviour (scale measure)

4 Discussion

The discussion section is subdivided into four parts. The first subsection (4.1) describes how well the behavioural intention to use the active transport modes daily for travel purposes, is explained by the eTPB framework. The second subsection (4.2) presents the related discussion on how well three self-reported measures of behaviour of using active transport modes daily for travel purposes, are explained by the extended TPB framework. The third subsection (4.3) presents the moderating role of habit strength in explaining the intention-behaviour relationship. Besides, the last section (4.4) highlights the limitations and strengths of the current study.

4.1 Intention to use the active transport modes daily for travel purposes

Consistent with the TPB theoretical framework, attitude, SNs and PBC towards the use of active transport modes explained 38% variance in the intention to use active transport modes (walking or cycling for at least 10 minutes/day) for travel purposes. This result is in confirmation with previous studies of relevant behaviours, i.e., pro-environment and performing PA (Bamberg & Möser, 2007; Davies, Mummery, & Steele, 2010; Plotnikoff, Lippke, Courneya, Birkett, & Sigal, 2010). Adding habit strength to this model increased the 21% variance explained in the intention to use active transport modes. It is also confirmed by other studies that habit strength is strongly relevant in explaining the behavioural intention of mode choice related behaviour (Fu, 2020; Gardner, 2009; Murtagh et al., 2012; Thøgersen, 2006).

4.2 Using active transport modes daily for travel purposes

The current study used three types of self-reported measures of active transport modes use; 1) the combination of single scale measures of walking or cycling frequency; 2) direct ATS (PA calculated by multiplying the directly reported average time spent/day for walking or cycling for transportation with the corresponding MET values from the compendium 2011 of activities, and 3) indirect ATS (PA calculated by combining the duration spent on the trips by walking or cycling from the self-reported one-day travel diary and then multiplying with the corresponding MET values). The scale measure of the behaviour achieved a higher explained variance by the TBP constructs together with habit strength in comparison to the other measures. Interestingly, the bivariate correlation between the direct and the scale measure of behaviour is stronger in comparison to the indirect and scale measure. However, the variance explained by the direct measure is far less than it is explained by the scale measure of behaviour. These results do not coincide with previous literature. For example, studies using direct measures explained better variance in the behaviour such as car use commuting (i.e., 52%), adult active transportation (i.e., 26%) and active commute (i.e., 41%) (Abrahamse, Steg, Gifford, & Vlek, 2009; Gert Jan de Bruijn et al., 2009; Lemieux & Godin, 2009), by TPB constructs using convenience samples of student and employees. Additionally, the scale measure of behaviour in the following studies predicted the driving behaviour even up to 67% (Elliott et al., 2007; Paris & Van den Broucke, 2008) in random driving license holders and a convenient sample of civil servants. Other studies using the indirect measure of PA and transport-related cycling also successfully predicted the behaviour by TPB constructs up to 43% (Maddison et al., 2009; Zhang, Zhang, Gan, Li, & Rhodes, 2019), in students (between 12-17 years) and employees.

A variety of measurement methods for behaviour are used in the literature and are predicted well, as explained above. Two possible explanations of the lack of significant relations between the TPB construct and direct and indirect measurements of behaviour in the current study are discussed. The first possibility stems from the concept of the TPB itself, as the pioneering author of the TPB, Icek Ajzen, has stated that the theory is intuitively reasonable in explaining planned behaviours and intentions. Whether the behavioural intention is translated into actual behaviour, is a matter of external factors beyond the individual's control (Ajzen, 2011, 2020). This argument might justify the little success to predict direct and indirect self-reported behaviour in the current study. The use of active transport modes for travel purposes immanently means outdoor functional activities and are subject to various external barriers such as weather, the complexity of trip purposes, the burden of carrying things, etc. (Ton, Duives, Cats, Hoogendoorn-Lanser, & Hoogendoorn, 2019). Likewise, the strong habitual use of the car in routine trips can also affect the intention to use active transport modes (Aarts & Dijksterhuis, 2000b; Gardner, 2009). Despite these barriers to behaviour performance, the discordance between the intention-behaviour relationship exists and is a well-established fact in PA and exercise behaviours (G. J. de Bruijn & Rhodes, 2011; Rhodes & Bruijn, 2013; Rhodes & Yao, 2015). A meta-analysis aiming to quantify the intention-behaviour gap in PA, suggests that nearly twice as many people fail to translate their intention into reality as those who do (Rhodes & Bruijn, 2013).

The second explanation of the lack of relationship between the TPB construct and direct and indirect behaviour measures relates to the lack of compatibility of measures of behaviour and its psychological precursors. This possibility was also discussed in a study where a single-item measure of walking (scale measurement as required by the TPB) was better predicted than the self-reported measure through PA recall (indirect measure) or another objective measure (pedometer) (Scott et al., 2007). The difference in the means of direct ($\bar{x} = 8.5$) and indirect ($\bar{x} = 4.99$) measures of the behaviour indicates that the direct reporting of time spent on active transport modes was over-estimated to almost double, as calculated from their self-reported recall travel diary. This questions the reliability of self-reported direct measures representing the actual behaviour. Self-reported measures are known to be influenced by many biases, such as social desirability, seasonal effects and age, in addition to other cognitive and affective biases (Elliott et al., 2007; Vanhees et al., 2005). In PA as well as in the transportation domain, self-reported measures of behaviour are associated with over-estimation in comparison to the objective measurements of behaviour (Kelly, Krenn, Titze, Stopher, & Foster, 2013; Panter, Costa, Dalton, Jones, & Ogilvie, 2014; Vanhees et al., 2005). However, if the three measures used in the current study are compared in terms of mental effort, we see that scale measure requires the least mental effort to fill in the response, and maximum responses were received from this measure. The directly measured behaviour requires a bit more mental effort than the scale measure, as participants must recall their aggregated average minutes spent on each mode. The indirect measure requires the most mental effort, and therefore the least number of responses were received in this case. Here, we discern the opportunity to question the representation of the compatible scale measure of the behaviour as an actual behaviour. Exploiting the example from our own study, where the scale measure was described as *How often have* *you walked (at least 10 minutes/day) for travel purposes during the last 3 weeks?;* the type of responses gave vague information of using the transport modes frequency in terms of daily, a few days a week, etc. No doubt, the formulation of the question could have been improved. However, this scale measure was predicted better among other direct and indirect measures; while the latter measures of behaviour present the behaviour more precisely. Particularly, the direct measure was expected to be predicted better, as it is better correlated to scale measure as well as being theoretically compatible to its precursors. The lack of significance for the direct measure might be attributed to the unfamiliarity with the behaviour (e.g., CHD patients might be better familiar with enhancing the leisure-time walking and cycling than for travel purposes) or simply not performing the behaviour. This might have caused discordance between the responses of different behaviour measures asked differently; how often (scale measure), on average per day (direct measure) and which actual trips on a day (indirect measure), and thus led to variability in prediction by TPB. This also led to convincing us that probably the major part of the explained variance, e.g., in scale measure, is due to the Common Method Variance (CMV). The speculation about predicting the more compatible measures of behaviour partly by CMV is also discussed in the literature (Scott et al., 2007; Sutton, 1998). If all measures (behavioural and eTPB measures) required for response are collected in a single survey and at the same time, there is the possibility that the resulting relationships among the measuring constructs are distorted. This bias is called CMV and it inflates the estimated relationship between one construct and another (Rodríguez-Ardura & Meseguer-Artola, 2020). However, when using the TPB, it is required to have compatibility and correspondence between behaviour and TPB constructs measures, in order to match the cause and effect (Ajzen, 2002a, 2020; Sutton, 1998). The discussion regarding the CMV and self-reported scale measures in the relevant literature of TPB applications is rarely made explicit. This is probably due to a lack of comparative studies using different types of different implicit behavioural measures in parallel. Withal, the possibility of CMV influence is only mentioned in a meta-analysis related to the TPB (Armitage & Conner, 2001).

Furthermore, habit strength was a significant predictor of behaviour in the scale measure and direct measure of behaviour, but not in the indirect measure of behaviour. Therefore, it is assumed that habit strength is an important construct in explaining the use of active transport modes. A meta-analysis of 58 studies aiming to understand the transport mode choice behaviour, also suggested that habits and past behaviour are the most relevant predictors (Lanzini & Khan, 2017). However, concerning the indirect measure of the behaviour, it was calculated from a one-day travel diary, which is inherently not representative of the habitual use of active transport mode. Therefore, the insignificant main effect and negative relationship of habit strength with behaviour can be justified. Future studies are recommended to consider multiple-day travel diary to explain the related effect of habit on the use of active transport mode.

To conclude this section, the limitations proposed by Sniehotta et al., 2014 are recognisable in the current study, as the TPB is less predictive for a population at risk, type of behaviour and behavioural measurement methods (McEachan, Conner, Taylor, & Lawton, 2011; Scott et al., 2007; Sniehotta, Presseau, & Araújo-Soares, 2014). A meta-analysis of non-adherence behaviour in chronic illnesses performed by Rich, Brandes, Mullan, & Hagger, 2015, also reflects on this (Rich et al., 2015). In future studies, it is recommended to compare different explicit and implicit methods (Gawronski & Hahn, 2019) to measure the behaviour and to discuss the association of self-reported explicit measures, i.e., scale measure with representative implicit behaviour measures (i.e., direct and indirect behaviour measures). This will highlight the inconsistent predictive utility of the TPB across different behaviour measures (Hobbs, Dixon, Johnston, & Howie, 2012), thus adding further understanding in the target behaviour, i.e., the use of active transport modes. Moreover, Ajzen (2020) recommended that the inclusion of the TPB constructs measures of the alternatives in the choice situations can account for an additional explanation of behaviour (Ajzen, 2020). Likewise, in a car-dependent society, measuring the corollary habitual strength of alternative transport modes such as car use might explain the use of active transport mode better, as also observed in several studies (Møller & Thøgersen, 2008; Murtagh et al., 2012).

4.3 Moderating role of habit strength

Simple correlation showed that habit and intentions are strongly correlated. However, habit strength significantly moderated the relationship only between the scale measure of behaviour and behavioural intention. The results showed that when habits are weak, behavioural intention is relevant to predict the behaviour, which is in line with previous findings, albeit in a negative way. It is a fact that intention is a weak to non-significant predictor of behaviour in case of strong habits, and a significant factor in case of low to medium habits (Bamberg & Schmidt, 2003; G.-J. de Bruijn & Gardner, 2011; Gert Jan De Bruijn et al., 2007). This relates to the theory of interpersonal behaviour by Triandis (1977), which predates the modern dual systems models of information processing (Sherman, Gawronski, & Trope, 2014). According to this dual system approach, habit and intention are both antecedents of behaviour. Their weight in predicting the behaviour varies opposite to each other; if the influence of intentions is strong then the habit will be weak and vice versa (Bas Verplanken, 2018). The decomposition of the relationship between habit strength and behaviour showed that in the case of weak habits, participating CHD patients having more intention used less active transport modes. In previous studies, the opposite link of strong habit and weak intentions is usually found significant and discussed (G.-J. de Bruijn & Gardner, 2011; Gert Jan De Bruijn et al., 2007; Gert Jan de Bruijn et al., 2009). However, this might depend on the nature of the behaviour, as the use of active transport was not performed habitually by participating CHD patients, but being environmentally friendly and healthy behaviour, participants showed intention for it. This further relates to the intention-behaviour gap (Rhodes & Bruijn, 2013; Rhodes & Yao, 2015) which refers to the fact that having high intentions towards behaviour, i.e., the use of active transport, doesn't mean that these are translated into reality. Thus, low volitional control over the behaviour was observed, which is probably due to external factors, as discussed. However, to minimize this intention-behaviour gap, many post-intention or motivation models are used, which include volitional regulatory behaviour (e.g., action planning and planning to cope with anticipated barriers), endogenous factors (e.g., social ecology), habit formation, identity, self-efficacy, outcome expectation, etc. (Rhodes & Yao, 2015; Zhang et al., 2019).

4.4 Limitations and strengths

The results of the current study should be used by taking into consideration the following limitations. First, the data used for this study was part of a larger study, which included TPB constructs and habit strength to get a better socio-cognitive overview of the use of active transport modes of CHD patients, to inform the intervention design for future study. Therefore, to reduce the burden on participants, a shorter version of the SRHI was used, which could consist of an incomplete representation of habitual behaviour. Either, a complete SRHI or a shorter version, whose reliability has been fairly tested in the literature such as, 'Self-Report Behavioural Automaticity Index' (SRBAI), can be used (Gardner et al., 2012). Second, the results are limited to the dominant amount of male subjects in the population (85.5%), and therefore, caution should be taken before generalizing the findings. Third, although a large number of cross-sectional studies are present in the literature (Gert Jan de Bruijn, Kroeze, Oenema, & Brug, 2008; Menozzi, Sogari, & Mora, 2015; Mullan, Allom, Sainsbury, & Monds, 2015) validating the TPB framework, a powerful longitudinal research design in future can help validate the findings of the current cross-sectional study for the population at risk, i.e. CHD patients, along with comparing different measurement methods of behaviour. Fourth, the result of indirect measures showed that the habitual use of active transport is not accounted for by one-day travel diaries. Therefore, the use of a multiple-day travel diary is recommended for future confirmatory studies. A multiple-day travel diary is considered a better source of information, but due to the high cost and additional burden on respondents, the use of one-day diaries is yet common practice to get a general overview of the travel behaviour pattern (Prelipcean, 2018). Finally, in the current study, the sample size used was small, leading to small effect sizes. Therefore, generalizing these results to the whole population of CHD patients might not be suitable. The study results can be used for hypothesis generation, and it is recommended to replicate and extend the findings from the current study with a large sample.

Nevertheless, we believe that this study contributes to the literature, due to the following strengths. The first strength of the current study is that the investigation of three different self-reported behaviour measures across the same population can help to understand the congruence in the prediction by TPB. Secondly, it is the first time that the use of active transport modes in a randomly selected at-risk population, i.e., CHD patients, has been explained by the TPB and habit strength. Finally, it has assessed an important issue (the use of active transport modes) that can contribute to the health benefits of patients with heart diseases, by providing an understanding of the behaviour as well as of the future direction for the interventions.

5 Conclusions

The net health benefits of the use of active transport modes are acknowledged in previous literature. Enhancing the share of active transport modes in the daily routine of CHD patients can play a positive role in secondary prevention. The current study aimed to examine the utility of the extended TPB framework with habit strength in explaining the intention to use active transport modes, and the behaviour to use active transport modes, during the daily travel routine of CHD patients, using three types of self-reported measures of behaviour. The results indicate that the extended TPB framework with habit strength fairly (up to 59% variance) explained the intention to use active transport modes of CHD patients. On the contrary, different behavioural measures were explained differently by the TPB constructs and habit strength. The scale measure of behaviour was best predicted (up to 21%) by TPB and habit strength among the rest measures. The direct and indirect measures of use of active transport modes were relatively poorly explained (up to 3% and 10% only, respectively) by the extended TPB framework. The habit strength moderated the relationship between behaviour and behavioural intention only in the case of scale measure of behaviour, but not in the case of direct and indirect measures of behaviour. In the case of weak habits, the intention was a significant precursor of the behaviour. Surprisingly, higher behavioural intention resulted in a lower behavioural frequency, confirming the intention-behaviour gap. The study findings highlight the limitation of the variable predictive utility of the TPB across different types of behaviour measures of the use of active transport modes of at-risk populations. However, considering this study a hypothesis-generating, further research is necessary to replicate and extend these findings with a larger cohort.

Acknowledgements:

I would like to acknowledge Dr Pieter Vandervoort for facilitating this research at ZOL’s cardiology department and related rehabilitation centre. I am thankful for the cooperation of the staff of the rehabilitation centres at Jessa and ZOL hospitals, especially the paramedical department head Kim Bonne, and the physiotherapist of cardiac rehabilitation Toon Alders at Jessa hospital, for their support and facilitation during the recruitment. I would like to pay my special regards to the students who have provided their assistance in the recruitment and data collection.

References

Aarts, H., & Dijksterhuis, A. (2000a). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology*, *78*(1), 53–63. https://doi.org/10.1037/0022-3514.78.1.53

Aarts, H., & Dijksterhuis, A. (2000b). THE AUTOMATIC ACTIVATION OF GOAL-DIRECTED BEHAVIOUR: THE CASE OF TRAVEL HABIT. *Journal of Environmental Psychology*, *20*(1), 75–82. https://doi.org/10.1006/JEVP.1999.0156

Aarts, H., Verplanken, B., & Knippenberg, A. van. (1998). Predicting Behavior From Actions in the Past: Repeated Decision Making or a Matter of Habit? *Journal of Applied Social Psychology*, *28*(15), 1355–1374. https://doi.org/10.1111/J.1559-1816.1998.TB01681.X

Abrahamse, W., Steg, L., Gifford, R., & Vlek, C. (2009). Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality? *Transportation Research Part F: Traffic Psychology and Behaviour*, *12*(4), 317–324. https://doi.org/10.1016/j.trf.2009.04.004

Ades, P. A., & Savage, P. D. (2017). Obesity in Coronary Heart Disease: An Unaddressed Behavioral Risk Factor. *Preventive Medicine*, *104*, 117. https://doi.org/10.1016/J.YPMED.2017.04.013

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett, D. R., Tudor-Locke, C., … Leon, A. S. (2011). 2011 Compendium of Physical Activities. *Medicine & Science in Sports & Exercise*, *43*(8), 1575–1581. https://doi.org/10.1249/MSS.0b013e31821ece12

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2002a). Constructing a TpB Questionnaire : Conceptual and Methodological Considerations. Retrieved from https://www.semanticscholar.org/paper/Constructing-a-TpB-Questionnaire-%3A-Conceptual-and-Ajzen/0574b20bd58130dd5a961f1a2db10fd1fcbae95d

Ajzen, I. (2002b). Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior [1]. *Journal of Applied Social Psychology*, *32*(4), 665–683. https://doi.org/10.1111/j.1559-1816.2002.tb00236.x

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology & Health*, *26*(9), 1113–1127. https://doi.org/10.1080/08870446.2011.613995

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies*, *2*(4), 314–324. https://doi.org/10.1002/hbe2.195

Ajzen, I., Czasch, C., & Flood, M. G. (2009). From Intentions to Behavior: Implementation Intention, Commitment, and Conscientiousness. *Journal of Applied Social Psychology*, *39*(6), 1356–1372. https://doi.org/10.1111/j.1559-1816.2009.00485.x

Akbar, H., Anderson, D., & Gallegos, D. (2015). Predicting intentions and behaviours in populations with or at-risk of diabetes: A systematic review. *Preventive Medicine Reports*, *2*, 270–282. https://doi.org/10.1016/J.PMEDR.2015.04.006

Akoglu, H. (2018, September 1). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine*. Emergency Medicine Association of Turkey. https://doi.org/10.1016/j.tjem.2018.08.001

Albarracín, D., Kumkale, G. T., & Johnson, B. T. (2004). Influences of social power and normative support on condom use decisions: A research synthesis. *AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV*, *16*(6), 700–723. https://doi.org/10.1080/09540120412331269558

Armitage, C. J. (2005). Can the theory of planned behavior predict the maintenance of physical activity? *Health Psychology*, *24*(3), 235–245. https://doi.org/10.1037/0278-6133.24.3.235

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*, *40*(4), 471–499. https://doi.org/10.1348/014466601164939

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, *27*(1), 14–25. https://doi.org/10.1016/j.jenvp.2006.12.002

Bamberg, S., & Schmidt, P. (2003). Incentives, Morality, Or Habit? Predicting Students' Car Use for University Routes With the Models of Ajzen, Schwartz, and Triandis. *Environment and Behavior*, *35*(2), 264–285. https://doi.org/10.1177/0013916502250134

Batool, T., Knapen, L., Vanrompay, Y., Neven, A., Brijs, K., Ross, V., … Wets, G. (2018). Design of a feedback intervention to increase travel related physical activity of CVD patients. *Procedia Computer Science*, *141*, 434–441. https://doi.org/10.1016/J.PROCS.2018.10.170

Batool, T., Neven, A., Scherrenberg, M., Smeets, C. J. P., Dendale, P., Vanrompay, Y., … Janssens, D. (2021). Travel behaviour characteristics of Ischemic Heart Disease patients, potential to improve physical activity | Manuscript submitted for publication. Retrieved August 30, 2021, from https://www.researchgate.net/publication/354204574_Travel_behaviour_characteristics_of_Ischemic_Heart_Disease_patients_potential_to_improve_physical_activity

Batool, T., Neven, A., Smeets, C., Scherrenberg, M., Dendale, P., Vanrompay, Y., … Wets, G. (2021). Randomized controlled trial to enhance travel-related physical activity: a pilot study in patients with Ischemic Heart Disease | Manuscript submitted for publication. Retrieved March 25, 2021, from https://www.researchgate.net/publication/350374890_Randomized_control_trial_to_enhance_travel-related_physical_activity_a_pilot_study_in_patients_with_Ischemic_Heart_Disease

Batool, T., Vanrompay, Y., Neven, A., Janssens, D., & Wets, G. (2018). CTASS: an intelligent framework for personalized travel behaviour advice to cardiac patients. *Journal of Ambient Intelligence and Humanized Computing*, 1–13. https://doi.org/10.1007/s12652-018-0847-7

Bird, E. L., Panter, J., Baker, G., Jones, T., & Ogilvie, D. (2018). Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour, *10*, 11–27. Retrieved from https://www.sciencedirect.com/science/article/pii/S221414051730590X#bib57

Brown, V., Moodie, M., Cobiac, L., Mantilla, H., & Carter, R. (2017). Obesity-related health impacts of active transport policies in Australia - a policy review and health impact modelling study. *Australian and New Zealand Journal of Public Health*, *41*(6), 611–616. https://doi.org/10.1111/1753-6405.12726

Brug, J., Vet, E. de, Nooijer, J. de, & Verplanken, B. (2006). Predicting Fruit Consumption: Cognitions, Intention, and Habits. *Journal of Nutrition Education and Behavior*, *38*(2), 73–81. https://doi.org/10.1016/j.jneb.2005.11.027

Bruijn, G.-J. de, & Gardner, B. (2011). Active commuting and habit strength: An interactive and discriminant analyses approach. *American Journal of Health Promotion*, *25*(3), e27–e36. https://doi.org/10.4278/ajhp.090521-QUAN-170

Bruijn, G. J. de, Kremers, S. P. J., Singh, A., Putte, B. van den, & van Mechelen, W. (2009). Adult Active Transportation. Adding Habit Strength to the Theory of Planned Behavior. *American Journal of Preventive Medicine*, *36*(3), 189–194. https://doi.org/10.1016/j.amepre.2008.10.019

Bruijn, G. J. De, Kremers, S. P. J., Vet, E. De, Nooijer, J. De, Mechelen, W. van, & Brug, J. (2007). Does habit strength moderate the intention-behaviour relationship in the Theory of Planned Behaviour? the case of fruit consumption. *Psychology and Health*, *22*(8), 899–916. https://doi.org/10.1080/14768320601176113

Bruijn, G. J. de, Verkooijen, K., Vries, N. K. de, & Putte, B. van den. (2012). Antecedents of self identity and consequences for action control: An application of the theory of planned behaviour in the exercise domain. *Psychology of Sport and Exercise*, *13*(6), 771–778. https://doi.org/10.1016/j.psychsport.2012.05.008

Conn, V. S., Hafdahl, A. R., Moore, S. M., Nielsen, P. J., & Brown, L. M. (2009). Meta-analysis of interventions to increase physical activity among cardiac subjects. *International Journal of Cardiology*, *133*(3), 307–320. https://doi.org/10.1016/j.ijcard.2008.03.052

Conner, M., & Armitage, C. J. (1998, August 1). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology*. Bellwether Publishing, Ltd. https://doi.org/10.1111/j.1559-1816.1998.tb01685.x

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research and Evaluation*, *10*(7). Retrieved from https://www.amazon.com/Best-Practices-Exploratory-Factor-Analysis/dp/1500594342

Davies, C. A., Mummery, W. K., & Steele, R. M. (2010). The relationship between personality, theory of planned behaviour and physical activity in individuals with type II diabetes, *44*(13), 979–984. https://doi.org/10.1136/bjsm.2008.050930

de Almeida Mendes, M., da Silva, I., Ramires, V., Reichert, F., Martins, R., Ferreira, R., & Tomasi, E. (2018). Metabolic equivalent of task (METs) thresholds as an indicator of physical activity intensity. *PLoS ONE*, *13*(7). https://doi.org/10.1371/journal.pone.0200701

de Bruijn, G. J., Kroeze, W., Oenema, A., & Brug, J. (2008). Saturated fat consumption and the Theory of Planned Behaviour: Exploring additive and interactive effects of habit strength. *Appetite*, *51*(2), 318–323. https://doi.org/10.1016/j.appet.2008.03.012

de Bruijn, G. J., & Rhodes, R. E. (2011). Exploring exercise behavior, intention and habit strength relationships. *Scandinavian Journal of Medicine & Science in Sports*, *21*(3), 482–491. https://doi.org/10.1111/j.1600-0838.2009.01064.x

Donald, I. J., Cooper, S. R., & Conchie, S. M. (2014). An extended theory of planned behaviour model of the psychological factors affecting commuters' transport mode use. *Journal of Environmental Psychology*, *40*, 39–48. https://doi.org/10.1016/j.jenvp.2014.03.003

Elliott, M. A., Armitage, C. J., & Baughan, C. J. (2007). Using the theory of planned behaviour to predict observed driving behaviour. *British Journal of Social Psychology*, *46*(1), 69–90. https://doi.org/10.1348/014466605X90801

F Piepoli, M. (2017). 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representati. *International Journal of Behavioral Medicine*, *24*(3), 321–419. https://doi.org/10.1007/s12529-016-9583-6

Friedrichsmeier, T., Matthies, E., & Klöckner, C. A. (2013). Explaining stability in travel mode choice: An empirical comparison of two concepts of habit. *Transportation Research Part F: Traffic Psychology and Behaviour*, *16*, 1–13. https://doi.org/10.1016/J.TRF.2012.08.008

Fu, X. (2020). How habit moderates the commute mode decision process: integration of the theory of planned behavior and latent class choice model. *Transportation 2020*, 1–27. https://doi.org/10.1007/S11116-020-10144-6

Gardner, B. A review and analysis of the use of "habit" in understanding, predicting and influencing health-related behaviour, *9*(3), 277–295. https://doi.org/10.1080/17437199.2013.876238

Gardner, B. (2009). Modelling motivation and habit in stable travel mode contexts. *Transportation Research Part F: Traffic Psychology and Behaviour*, *12*(1), 68–76. https://doi.org/10.1016/j.trf.2008.08.001

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 102. https://doi.org/10.1186/1479-5868-9-102

Gardner, B., De Bruijn, G. J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine*, *42*(2), 174–187. https://doi.org/10.1007/s12160-011-9282-0

Gardner, B., & Tang, V. (2014). Reflecting on non-reflective action: An exploratory think-aloud study of self-report habit measures. *British Journal of Health Psychology*, *19*(2), 258–273. https://doi.org/10.1111/bjhp.12060

Gawronski, B., & Hahn, A. (2019). Implicit measures: Procedures, use, and interpretation. - PsycNET. *Frontiers of Social Psychology*, (Measurement in social psychology), 22–55. Retrieved from https://psycnet.apa.org/record/2019-06891-002

Gaze, C. D. (2013). Introduction to Ischemic Heart Disease. In *Ischemic Heart Disease*. InTech. https://doi.org/10.5772/55248

Gollwitzer, P. M., & Bargh, J. A. (1996). *The psychology of action : linking cognition and motivation to behavior*. Guilford Press. Retrieved from https://books.google.be/books/about/The_Psychology_of_Action.html?id=v1LQVSI9hfMC&redir_esc=y

Gourlan, M., Bernard, P., Bortolon, C., Romain, A. J., Lareyre, O., Carayol, M., … Boiché, J. (2016). Efficacy of theory-based interventions to promote physical activity. A meta-analysis of randomised controlled trials. *Health Psychology Review*, *10*(1), 50–66. https://doi.org/10.1080/17437199.2014.981777

Greaves, C. J., Sheppard, K. E., Abraham, C., Hardeman, W., Roden, M., Evans, P. H., & Schwarz, P. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions, 11 BMC Public Health § (2011). BioMed Central. https://doi.org/10.1186/1471-2458-11-119

Guénette, L., Breton, M. C., Guillaumie, L., Lauzier, S., Grégoire, J. P., & Moisan, J. (2016). Psychosocial factors associated with adherence to non-insulin antidiabetes treatments. *Journal of Diabetes and Its Complications*, *30*(2), 335–342. https://doi.org/10.1016/j.jdiacomp.2015.10.016

Hagger, M. S., Chatzisarantis, N. L. D., & Biddle, S. J. H. (2002). A Meta-Analytic Review of the Theories of Reasoned Action and Planned Behavior in Physical Activity: Predictive Validity and the Contribution of Additional Variables. *Journal of Sport and Exercise Psychology*, *24*(1), 3–32. https://doi.org/10.1123/JSEP.24.1.3

Hardeman, W., Johnston, M., Johnston, D., Bonetti, D., Wareham, N., & Kinmonth, A. L. (2002). Application of the Theory of Planned Behaviour in Behaviour Change Interventions: A Systematic Review. *Psychology & Health*, *17*(2), 123–158. https://doi.org/10.1080/08870440290013644a

Hardeman, W., Kinmonth, A. L., Michie, S., & Sutton, S. (2011). Theory of planned behaviour cognitions do not predict self-reported or objective physical activity levels or change in the ProActive trial. *British Journal of Health Psychology*, *16*(1), 135–150. https://doi.org/10.1348/135910710X523481

Hobbs, N., Dixon, D., Johnston, M., & Howie, K. (2012). Can the theory of planned behaviour predict the physical activity behaviour of individuals? *http://dx.doi.org/10.1080/08870446.2012.716838*, *28*(3), 234–249. https://doi.org/10.1080/08870446.2012.716838

Honkanen, P., Olsen, S. O., & Verplanken, B. (2005). Intention to consume seafood—the importance of habit. *Appetite*, *45*(2), 161–168. https://doi.org/10.1016/J.APPET.2005.04.005

Howard, M. C. (2016). A Review of Exploratory Factor Analysis Decisions and Overview of Current Practices:

What We Are Doing and How Can We Improve? *International Journal of Human-Computer Interaction*, *32*(1), 51–62. https://doi.org/10.1080/10447318.2015.1087664

Jetté, M., Sidney, K., & Blümchen, G. (1990). Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clinical Cardiology*, *13*(8), 555–565. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2204507

Kelly, P., Krenn, P., Titze, S., Stopher, P., & Foster, C. (2013). Quantifying the Difference Between Self-Reported and Global Positioning Systems-Measured Journey Durations: A Systematic Review. *Transport Reviews*, *33*(4), 443–459. https://doi.org/10.1080/01441647.2013.815288

Kerr, A., Lennon, A., & Watson, B. (2010). The call of the road: Factors predicting students' car travelling intentions and behaviour. *Transportation*, *37*(1), 1–13. https://doi.org/10.1007/s11116-009-9217-9

Kim, J. H. (2019). Multicollinearity and misleading statistical results. *Korean Journal of Anesthesiology*, *72*(6), 558. https://doi.org/10.4097/KJA.19087

Lally, P., Van Jaarsveld, C. H. M., Potts, H. W. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology*, *40*(6), 998–1009. https://doi.org/10.1002/ejsp.674

Lanzini, P., & Khan, S. A. (2017). Shedding light on the psychological and behavioral determinants of travel mode choice: A meta-analysis. *Transportation Research Part F: Traffic Psychology and Behaviour*, *48*, 13–27. https://doi.org/10.1016/j.trf.2017.04.020

Lemieux, M., & Godin, G. (2009). How well do cognitive and environmental variables predict active commuting? *International Journal of Behavioral Nutrition and Physical Activity*, *6*(1), 12. https://doi.org/10.1186/1479-5868-6-12

Lin, C. Y., Updegraff, J. A., & Pakpour, A. H. (2016). The relationship between the theory of planned behavior and medication adherence in patients with epilepsy. *Epilepsy and Behavior*, *61*, 231–236. https://doi.org/10.1016/j.yebeh.2016.05.030

Lizana, M., Tudela, A., & Tapia, A. (2021). Analysing the influence of attitude and habit on bicycle commuting. *Transportation Research Part F: Traffic Psychology and Behaviour*, *82*, 70–83. https://doi.org/10.1016/J.TRF.2021.07.015

Lockyer, N. (2001). Nature. *Nature*, *410*. Retrieved from http://tl3ry3ge2c.scholar.serialssolutions.com/?sid=google&auinit=KR&aulast=Westerterp&atitle=Pattern+and+intensity+of+physical+activity&id=doi:10.1038/35069142&title=ON+nature&volume=410&issue=6828&date=2001&spage=539&issn=0028-0836

MacKinnon, D. P., Fairchild, A. J., & Fritz, M. S. (2007). Mediation Analysis. *Annual Review of Psychology*, *58*, 593. https://doi.org/10.1146/ANNUREV.PSYCH.58.110405.085542

Maddison, R., Hoorn, S. Vander, Jiang, Y., Mhurchu, C. N., Exeter, D., Dorey, E., … Turley, M. (2009). The environment and physical activity: The influence of psychosocial, perceived and built environmental factors. *International Journal of Behavioral Nutrition and Physical Activity*, *6*(1), 19. https://doi.org/10.1186/1479-5868-6-19

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the Theory of Planned Behaviour: a meta-analysis. *Health Psychology Review*, *5*(2), 97–144. https://doi.org/10.1080/17437199.2010.521684

Menozzi, D., Sogari, G., & Mora, C. (2015). Explaining Vegetable Consumption among Young Adults: An Application of the Theory of Planned Behaviour. *Nutrients*, *7*, 7633–7650. https://doi.org/10.3390/nu7095357

Møller, B., & Thøgersen, J. (2008). Car Use Habits: An Obstacle to the Use of Public Transportation? *Advances in Spatial Science*, *55*, 301–313. https://doi.org/10.1007/978-3-540-77150-0_15

Mullan, B., Allom, V., Sainsbury, K., & Monds, L. A. (2015). Examining the predictive utility of an extended theory of planned behaviour model in the context of specific individual safe food-handling. *Appetite*, *90*, 91–98. https://doi.org/10.1016/j.appet.2015.02.033

Murtagh, S., Rowe, D. A., Elliott, M. A., McMinn, D., & Nelson, N. M. (2012). Predicting active school travel: The role of planned behavior and habit strength. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 65. https://doi.org/10.1186/1479-5868-9-65

Nordfjærn, T., Şimşekoılu, Ö., & Rundmo, T. (2014). The role of deliberate planning, car habit and resistance to change in public transportation mode use. *Transportation Research Part F: Traffic Psychology and Behaviour*, *27*(PA), 90–98. https://doi.org/10.1016/J.TRF.2014.09.010

Norman, P., Armitage, C. J., & Quigley, C. (2007). The theory of planned behavior and binge drinking: Assessing the impact of binge drinker prototypes. *Addictive Behaviors*, *32*(9), 1753–1768. https://doi.org/10.1016/j.addbeh.2006.12.009

Norman, P., Conner, M., & Bell, R. (1999). The theory of planned behavior and smoking cessation. *Health*

Psychology, *18*(1), 89–94. https://doi.org/10.1037/0278-6133.18.1.89

Panter, J., Costa, S., Dalton, A., Jones, A., & Ogilvie, D. (2014). Development of methods to objectively identify time spent using active and motorised modes of travel to work: How do self-reported measures compare? *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 116. https://doi.org/10.1186/s12966-014-0116-x

Paris, H., & Van den Broucke, S. (2008). Measuring cognitive determinants of speeding: An application of the theory of planned behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour*, *11*(3), 168–180. https://doi.org/10.1016/j.trf.2007.09.002

Plotnikoff, R. C., Courneya, K. S., Trinh, L., Karunamuni, N., & Sigal, R. J. (2008). Aerobic physical activity and resistance training: An application of the theory of planned behavior among adults with type 2 diabetes in a random, national sample of Canadians. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 1–14. https://doi.org/10.1186/1479-5868-5-61

Plotnikoff, R. C., Lippke, S., Courneya, K., Birkett, N., & Sigal, R. (2010). Physical activity and diabetes: An application of the theory of planned behaviour to explain physical activity for type 1 and type 2 diabetes in an adult population sample. *Psychology and Health*, *25*(1), 7–23. https://doi.org/10.1080/08870440802160984

Prelipcean, A. C. (2018). *MEILI : Multiple day travel behaviour data collection, automation and analysis*. KTH Royal Institute of Technology.

Revelle, W., & Zinbarg, R. E. (2008). Coefficients Alpha, Beta, Omega, and the glb: Comments on Sijtsma. *Psychometrika 2008 74:1*, *74*(1), 145–154. https://doi.org/10.1007/S11336-008-9102-Z

Rhodes, R. E., & Bruijn, G.-J. de. (2010). Automatic and Motivational Correlates of Physical Activity: Does Intensity Moderate the Relationship? *Behavioural Medicine*, *36*(2), 44–52. https://doi.org/10.1080/08964281003774901

Rhodes, R. E., & Bruijn, G. J. De. (2013). How big is the physical activity intention-behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology*, *18*(2), 296–309. https://doi.org/10.1111/bjhp.12032

Rhodes, R. E., & Yao, C. A. (2015). Models accounting for intention-behavior discordance in the physical activity domain: A user's guide, content overview, and review of current evidence. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 9. https://doi.org/10.1186/s12966-015-0168-6

Rich, A., Brandes, K., Mullan, B., & Hagger, M. S. Theory of planned behavior and adherence in chronic illness: a meta-analysis, 38 Journal of Behavioral Medicine § (2015). https://doi.org/10.1007/s10865-015-9644-3

Robert S. Wyer, J., Srull, T. K., & Srull, T. K. (2014). The Four Horsemen of Automaticity: Awareness, Intention, Efficiency, and Control in Social Cognition, 17–56. https://doi.org/10.4324/9781315807102-7

Rodríguez-Ardura, I., & Meseguer-Artola, A. (2020). Editorial: How to prevent, detect and control common method variance in electronic commerce research. *Journal of Theoretical and Applied Electronic Commerce Research*. Universidad de Talca. https://doi.org/10.4067/S0718-18762020000200101

Sallis, J. F., Floyd, M. F., Rodríguez, D. A., & Saelens, B. E. (2012). Role of Built Environments in Physical Activity, Obesity, and Cardiovascular Disease. *Circulation*, *125*(5), 729–737. https://doi.org/10.1161/CIRCULATIONAHA.110.969022

Scott, E. J., Eves, F. F., French, D. P., & Hoppé, R. (2007). The theory of planned behaviour predicts self-reports of walking, but does not predict step count. *British Journal of Health Psychology*, *12*(4), 601–620. https://doi.org/10.1348/135910706X160335

Sherman, J. W., Gawronski, B., & Trope, Y. (2014). *Dual-Process Theories of the Social Mind*. New York: The Guilford Press. Retrieved from https://books.google.be/books?hl=en&lr=&id=b8ZHAwAAQBAJ&oi=fnd&pg=PP1&dq=dual-process+theories+of+the+social+mind&ots=HfyvrpisDE&sig=lepsPBAlPKPvox5w4sPn_Tf-Nug#v=onepage&q=dual-process theories of the social mind&f=false

Shrestha, N. (2020). Detecting Multicollinearity in Regression Analysis. *American Journal of Applied Mathematics and Statistics*, *8*(2), 39–42. https://doi.org/10.12691/ajams-8-2-1

Sniehotta, F. F., Presseau, J., & Araújo-Soares, V. (2014). Time to retire the theory of planned behaviour. *Health Psychology Review*, *8*(1), 1–7. https://doi.org/10.1080/17437199.2013.869710

Sommer, L. (2011). The Theory Of Planned Behaviour And The Impact Of Past Behaviour. *International Business & Economics Research Journal (IBER)*, *10*(1). https://doi.org/10.19030/iber.v10i1.930

Spearman, C. (2019). The proof and measurement of association between two things. *Américan Journal of Psychology*, *15*(1), 72–101. https://doi.org/10.2307/1412159

Sutton, S. (1998). Predicting and Explaining Intentions and Behavior: How Well Are We Doing? *Journal of Applied Social Psychology*, *28*(15), 1317–1338. https://doi.org/10.1111/j.1559-1816.1998.tb01679.x

Thøgersen, J. (2006). Understanding repetitive travel mode choices in a stable context: A panel study approach.

Transportation Research Part A: Policy and Practice, *40*(8), 621–638. https://doi.org/10.1016/J.TRA.2005.11.004

Ton, D., Duives, D. C., Cats, O., Hoogendoorn-Lanser, S., & Hoogendoorn, S. P. (2019). Cycling or walking? Determinants of mode choice in the Netherlands. *Transportation Research Part A: Policy and Practice*, *123*, 7–23. https://doi.org/10.1016/j.tra.2018.08.023

Triandis, H. (1977). *Interpersonal behavior*. Monterey Calif.: Brooks/Cole Pub. Co.

Vanhees, L., Lefevre, J., Philippaerts, R., Martens, M., Huygens, W., Troosters, T., & Beunen, G. (2005). How to assess physical activity? How to assess physical fitness? *European Journal of Preventive Cardiology*, *12*(2), 102–114. https://doi.org/10.1097/01.hjr.0000161551.73095.9c

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology*, *45*(3), 639–656. https://doi.org/10.1348/014466605X49122

Verplanken, B. (2018). The psychology of habit: Theory, mechanisms, change, and contexts. *The Psychology of Habit: Theory, Mechanisms, Change, and Contexts*, 1–418. https://doi.org/10.1007/978-3-319-97529-0

Verplanken, B., & Aarts, H. (1999). Habit, Attitude, and Planned Behaviour: Is Habit an Empty Construct or an Interesting Case of Goal-directed Automaticity? *European Review of Social Psychology*, *10*(1), 101–134. https://doi.org/10.1080/14792779943000035

Verplanken, B., Aarts, H., Van Knippenberg, A., & Moonen, A. (1998). Habit versus planned behaviour: A field experiment. *British Journal of Social Psychology*, *37*(1), 111–128. https://doi.org/10.1111/j.2044-8309.1998.tb01160.x

Verplanken, B., & Knippenberg, A. Van. (1996). Habit, information acquisition, and the process of making travel mode choices. *European Journal of Social Psychology*, *27*, 539–560. https://doi.org/10.1002/(SICI)1099-0992(199709/10)27:5

Verplanken, B., Myrbakk, V., & Rudi, E. (2005). The measurement of habit. - PsycNET. *American Psychological Association*, 231–247. Retrieved from https://psycnet.apa.org/record/2005-00479-013

Verplanken, B., & Orbell, S. (2003). Reflections on Past Behavior: A Self-Report Index of Habit Strength1. *Journal of Applied Social Psychology*, *33*(6), 1313–1330. https://doi.org/10.1111/j.1559-1816.2003.tb01951.x

Verplanken, B., & Orbell, S. (2019). Habit and Behavior Change. In *Social Psychology in Action* (pp. 65–78). Springer International Publishing. https://doi.org/10.1007/978-3-030-13788-5_5

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology*, *28*(2), 121–127. https://doi.org/10.1016/J.JENVP.2007.10.005

Zamorano, J. L., García-Moll, X., Ferrari, R., & Greenlaw, N. (2014). Demographic and Clinical Characteristics of Patients With Stable Coronary Artery Disease: Results From the CLARIFY Registry in Spain. *Revista Española de Cardiología (English Edition)*, *67*(7), 538–544. https://doi.org/10.1016/j.rec.2013.10.020

Zapata-Diomedi, B., Knibbs, L. D., Ware, R. S., Heesch, K. C., Tainio, M., Woodcock, J., & Veerman, J. L. (2017). A shift from motorised travel to active transport: What are the potential health gains for an Australian city? *PLoS ONE*, *12*(10). https://doi.org/10.1371/journal.pone.0184799

Zhang, C. Q., Zhang, R., Gan, Y., Li, D., & Rhodes, R. E. (2019). Predicting transport-related cycling in Chinese employees using an integration of perceived physical environment and social cognitive factors. *Transportation Research Part F: Traffic Psychology and Behaviour*, *64*, 424–439. https://doi.org/10.1016/j.trf.2019.06.003