Exploring Influencing Factors of Technology use for Active and Healthy Ageing Support in Older Adults

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Abstract

Aim of this study is to investigate the influence of technological and social cognitive factors for the use of sensor-based technologies for active and healthy ageing (AHA) support by older adults. In a mixed methods approach, data was initially obtained from an online questionnaire completed by older health technology users and used in a regression analysis, where factors from the Technology Acceptance Model (TAM) and the Social Cognitive Theory (SCT) served as predictors for health technology use (HTU). Further, in-depth interviews were conducted with older adults to gain insights into technology use and physical activity behaviour of older adults. The regression analysis showed that the TAM and SCT factors accounted for a significant proportion of variance (39.5%) in HTU. Significant

predictors of HTU were physical activity (.399**), social support (.287*), and expectations regarding individual health (.440*) and physical appearance (-.470**), indicating physical activity as mediator for HTU. The qualitative analysis indicated the conflation of technology support with social environments as key for physical activity behaviour in older adults. The findings indicate physical activity as a mediator in HTU by older adults and suggest that the consideration of social factors in health technology design may facilitate the uptake of AHA technologies.

Keywords: technology acceptance model, health information technology, health, technology design, social cognitive theory

1 INTRODUCTION

With ongoing technological progress in terms of bandwidth, sensors and data analyses, more and more novel information- and communication technology (ICT)–based solutions edge into the market, providing support for active and healthy ageing (AHA) in a wide range of health domains, e.g. physical activity, cognition, nutrition, sleep, etc. (Walker and Maltby 2012). It is anticipated that these technologies ease the access to instruments that support a healthy lifestyle and improve individual health (Zaidi et al. 2017). Physical inactivity is known to be one major risk factor for chronic diseases, early mortality and increasing healthcare costs (I.-M. Lee et al. 2012). Technologies that quantify and provide feedback on physical activity seem to increase physical activity levels (Kang et al. 2009).

Previous literature has extensively investigated influencing factors for both the use of health technologies for active and healthy ageing support and health behaviour change at this target

group and has identified technology acceptance, intensity, progression, feedback, personal choice and integration into daily life routines as key aspects for sustainable and long-term participation in technology supported physical activity (Ballegaard, Hansen, and Kyng 2008; Carmichael et al. 2010). Further, the opportunity to network and communicate with peer groups, as well as the provision of goal setting and self-monitoring functionalities was found to be of major importance for older adults to stay involved and follow a technology-based activity program to improve their health and quality of life (Y. S. Lee et al. 2012). On the other hand, research on physical activity behaviour showed that determinants like health-literacy, self-efficacy, outcome expectations, goals, socio-cultural facilitators and impediments explain most of the variance in physical activity engagement in older adults (White, Wojcicki, and McAuley 2012; Son et al. 2009; Dishman et al. 2010; Trost et al. 2002). Such factors have been found to promote motivation in older adults to initiate health behaviour change.

Even though motivational aspects of physical activity engagement and influencing factors for (AHA) technology use in older adults have been studied extensively (Peek et al. 2014, 2016), sustainable and long-term technology supported physical activity engagement remains a major challenge. It is therefore debatable to what extent the sole use of quantitative or qualitative methods is capable to assess the whole spectrum of heterogeneous experiences of users such as motivational (positive) and 'hygiene' (negative) aspects, which affect their sustainable engagement in technology supported physical activity (Herzberg 1966; Herzberg, Mausner, and Snyderman 2011). Main aim of this study is to investigate predictors for health technologies that support physical activity in older adults. We argue that the combined use

of quantitative and qualitative methods may improve our understanding of the underlying factors predicting such health technology use (HTU) in older adults.

Therefore, in a first step, we conducted a regression analysis, based on factors derived from the technology acceptance model (TAM) and the social cognitive theory (SCT) to identify technological and social factors influencing technology supported physical activity. The TAM is an acknowledged theory that explains how people accept a technology and start to use it continuously. In its original form, TAM may explain up to 57% of the variance in technology use (Davis, Bagozzi, and Warshaw 1989; Igbaria, Guimaraes, and Davis 1995). For the TAM, we used the original variables proposed by Davis (Davis 1989), perceived usefulness (PU) and perceived ease of use (PEOU). The influence of both variables on technology acceptance in a healthcare context has been confirmed throughout several studies (Van Schaik, Bettany-Saltikov, and Warren 2002; Yi et al. 2006). To the TAM we also added technology experience as an external variable, as it has shown significant effects on technology use in healthcare studies (Ammenwerth, Iller, and Mahler 2006; Gagnon et al. 2006). The SCT (Bandura 1986) defines a set of psychosocial determinants (i.e., self-efficacy, outcome expectations, goals, and impediments and facilitators) that may help to understand a wide range of health behaviours, including physical activity. In previous studies, the SCT has been one of the most frequently applied models for understanding physical activity behaviour in older adults (McAuley and Blissmer 2000). For the SCT, we included the variables proposed by Bandura and other studies, namely outcome expectations, self-efficacy, barriers and social support (Bandura 1986). Studies showed the significant effects

of these variables on health behaviour (Heaney, C. A., & Israel 2008; Williams, Anderson, and Winett 2005).

Afterwards, using qualitative interviews we investigated the factors, which had a significant contribution in the models in more detail, with a focus on physical activity behaviour in older adults as it was indicated to be a key mediator for HTU in our study.

With this mixed methods approach we contribute to a more subtle and complete understanding of factors influencing HTU and physical activity engagement by older adults (Brannen 2005). The results will provide design implications that, if appropriately addressed in technology design, may create opportunities for long-term engagement in technology supported physical activity by older adults.

2 METHODS

2.1 Study design

In a first quantitative trial, hundred eighty-eight health-technology users completed an anonymized online questionnaire on HTU and physical activity behavior. Participants were recruited via the newsletter of Medisana, (an online platform/company, which distributes a variety of AHA technologies such as activity monitors, pulse oximeters, weight scales, etc.), which advertised the study's questionnaire. Goal of the quantitative study was to identify relevant factors for HTU.

Subsequently, we conducted a qualitative study with additional fifteen participants to explore the results from the quantitative trial in more detail and to elucidate the relevant factors for HTU. Due to anonymization reasons, participants from the quantitative sample could not be

contacted, therefore the fifteen persons from the qualitative study were recruited by distributing paper-based and electronic ads in newspapers, websites, senior clubs and similar institutions.

2.2 Participants

In total, 203 persons from across Germany participated in this study. As inclusion criteria, participants who completed the online questionnaire were required to possess at least one out of three sensor-based health technology devices used for physical activity purposes; an activity monitor, a pulse monitor or a pulse oximeter. Participants in the qualitative trial were able to choose at least one of those technologies for a period of two months to explore their usage experiences. Qualified research assistants trained the participants in the qualitative trial to use the technologies appropriately before the study began. Further, participants in the qualitative trial were only included if their technology experience was at least moderate, which would equal a score of 7. We used a simple self-designed technology experience questionnaire to assess their experience. (described in section 2.3.1).

For both the quantitative and qualitative study, only participants with an age between 50 to 90 years were included.

2.3 Data collection

2.3.1 Quantitative data collection

An online questionnaire was distributed among participants of the quantitative trial. We integrated three control questions to check the validity of responses. The questionnaire

included items on demographic characteristics and physical activity and assessed TAM and SCT constructs with the following validated scales in German language. With respect to the readability of this article, we translated all items into English language.

We measured perceived usefulness on a 4-item likert scale, ranging from 1-totally disagree to 7- totally agree, developed and validated by Kothgassner et al. (Kothgassner et al. 2013). With respect to perceived ease of use we applied a 3-item likert scale, ranging from 1-totally disagree to 7-totally agree (Kothgassner et al. 2013). In order to assess participants' technology experience, we asked them for functionalities that they frequently use on their mobile phone. A list of 14 items (for instance, I use messenger applications like WhatsApp", "I play games", "I write Emails") was provided with the possibility for multiple answers. Each item counted as 1 point. We defined a score of 7 as moderate technology experience.

In terms of SCT variables, we measured outcome expectations with respect to improvements in health and physical appearance (for instance loss of body weight) when using health technologies. Both scales used a 5-point likert scale, ranging from 1-totally disagree to 5-totally agree (Reinhard Fuchs 1994). Self-efficacy was assessed on a 7-item likert scale, ranging from 1-totally unsure to 7-totally sure (R. Fuchs and Schwarzer 1994). To find out about barriers impeding physical activity engagement we applied a 4-item likert scale, ranging from 1-not at all to 4-very much (Krämer and Fuchs 2010). The prevalence of social support for physical activity was measured on a 5-point likert scale, ranging from 1-almost never to 5-almost always (R. Fuchs 1997).

In addition to the TAM and SCT variables, we asked participants to quantify their hours per week engaged in physical activity defined as any form of activity for example, doing sports and other activities like for example stair ambulation, going for walks, gardening etc. Finally, in order to evaluate intensity of AHA technology use during the study, we asked participants to specify the hours per week they used the wearables and corresponding health applications.

2.3.2 Qualitative data collection

To understand older adults' perspectives and motivations for physical activity in more detail, we conducted semi-structured interviews with a focus on physical activity with fifteen participants. Interview questions concentrated on participants' motivation for being physically active, the importance of physical activity for them, their individual benefits and risks and their outcome expectations from being physically active. Participants were encouraged to elaborate freely on these topics. Prior to the semi-structured interviews, we asked participants for their age, technology experience and health status. To assess technology experience, participants were requested to state technologies and functionalities they frequently use; similar to the way we assessed technology experience for the quantitative trial. Health status was not measured objectively, but by asking participants about their current impairments and diseases and how they would describe their physical condition (rather fit or rather impaired). Two trained research assistants conducted and audio-recorded all interviews.

2.4 Data analysis

2.4.1 Statistical data analysis

Several filters were applied before data analysis in order to screen for the study's inclusion/exclusion criteria (e.g. older than 50 years and younger than 90 years) as well as in order to eliminate invalid/dishonest answers (e.g. reported more than 30 years of education and reported more than 168 hours per week health technology use). Participants scoring above/below the cut-off for one or more of these filters were excluded from the analyses. Furthermore, only participants who reported using at least one of the required devices were selected for the analyses. In total, from the initial 188 participants who completed the online questionnaire 87 participants were kept for analysis after the filters application. Data were incomplete for 25 participants, such that analyses were carried out on a total of 62 (11 female) participants (mean age 60.6 ± 8.3), with years of education 13.8 ± 4.3. A linear multiple regression analysis to evaluate the value of technology experience, ease of use, usefulness, self-efficacy, barriers, activity per week, health-related expectations, physical appearance-related expectations and social support in the prediction of self-reported technology use per week was conducted. All predictors were entered into the regression equation in the same step. Diagnostic tests of tolerance and variance inflation revealed all of the measures fell within acceptable ranges of collinearity. As a generally accepted rule of thumb we used a threshold of < 2.5 for Variance Inflation Factors (VIF). VIF values for each variable are listed in table 1.

Variables	VIF
Technology experience	1.148
ease of use	1.100
usefulness	1.419
self-efficacy	2.150
barriers	1.811
reported physical activity per week (hours)	1.432
social support	1.189
health-related expectations	2.327
Physical appearance-related expectations	1.667

Table 1. Variance Inflation Factors

2.4.2 Qualitative data analysis

Qualitative data material was analyzed by applying a thematic analysis approach (Braun and Clarke 2006). Based on transcribed audio files, four coders performed an inductive analysis of the data material and generated main categories. Each coder was a trained research assistant with at least six months experience in the field of technologies for AHA support in older adults. Coding discrepancies, for instance code duplicates or different perspectives on codes, were discussed and eliminated by adding, editing or deleting codes in mutual consent, based on the group discussion outcomes. The final code system covered categories relating to the perception of health, the motivation for physical activity, barriers for engaging in physical activity, participants' perceived usefulness and drawbacks of engaging in physical activity and their outcome expectations from engaging in physical activity. These topics were derived from the results of the quantitative trial that suggested physical activity as significant predictor for HTU. Based on the coded data material we derived indicators that encourage

participants in our sample to perform physical activity. Those indicators lead to specific implications for the design of sensor-based health technologies, which are presented in the discussion. For the analysis, coders used the software application MAXQDA^{TM} version 12.

3 RESULTS

3.1 Quantitative analysis: exploring predictors of health-related technology use

3.1.1 Descriptive statistics

This section presents the means and standard deviations for participants' scores on technology experience, ease of use, usefulness, self-efficacy, barriers, activity per week, health-related expectations, physical appearance-related expectations, and self-reported technology use and social support.

Variables	Mean	SD
Technology use (hours)	79,1	69,5
Technology experience	8,7	3,1
ease of use	4,5	0,8
usefulness	4,3	1,7
self-efficacy	4,5	1,2
barriers	2,1	0,4
reported physical activity per week (hours)	25,8	22,7
social support	1,6	0,6
health-related expectations	4,3	0,7
Physical appearance-related expectations	3,9	0,9

Table 2. Descriptive values for the predictor variables used in the regression analysis

3.1.2 Correlation analysis

A pearson's correlation analysis between technology use and the TAM and SCT variables, which were later added in the regression model was initially applied. In total, HTU showed significant positive (but very low) correlations only with physical activity per week (r=.322) and social support (r=.284). Interestingly, there was also a negative correlation between HTU and physical appearance-related outcomes.

3.1.3 Regression analysis

Finally, in order to examine the relative contributions of technology experience, ease of use, usefulness, self-efficacy, barriers, activity per week, health-related expectations, physical appearance-related expectations and social support in the prediction of technology use per week, a regression analysis was conducted. All predictor variables were entered in the same step of the analysis, resulting in 39.5% explained variance in self-reported technology use per week. Technology experience, ease of use, usefulness, self-efficacy, and barriers, failed to contribute significantly to the prediction of self-reported technology use per week. Beta weights for the regression equation indicated that physical activity per week ($\beta = .40$, $p < .01$), social support ($\beta = .29$, $p < .05$), health-related expectations ($\beta = .44$, $p < .05$) and physical appearance -related expectations ($\beta = -.47$, $p < .001$) made significant contributions to the prediction of self-reported technology use per week.

3.2 Qualitative Analysis: Indicators regarding influencing factors for physical activity in older adults

3.2.1 Sample characteristics

According to the conducted thematic analysis, five different topics of indicators were revealed that determine older adults' engagement in physical activity for our sample. This section will describe the results. Table 3 provides an overview of interviewed participants and their characteristics.

ID	Sex	Age	Technology Experience	Health Status
PN1	male	78	experienced	fit
PN2	female	74	experienced	impaired
PN3	male	74	experienced	fit
PN4	male	64	experienced	fit
PN5	male	71	experienced	fit
PN6	female	71	experienced	fit
PN7	female	85	experienced	impaired
PN8	female	75	experienced	fit
PN9	male	72	experienced	fit
PN10	female	90	moderate	impaired
PN11	female	83	moderate	fit
PN12	female	78	moderate	impaired
PN13	male	68	experienced	fit
PN14	female	81	moderate	impaired
PN15	female	75	experienced	impaired

Table 3. Characteristics of interviewed participants

3.2.2 Health improvement

A major topic, participants mentioned with respect to physical activity engagement, pertained health improvement. One participant stated that physical activity was mandatory for her to

prevent falls and related consequences: *"I need to do that [physical activity] to keep being steady on the legs. If I fall for instance, I would need a wheel chair. So this [being physically active] is very serious for me." (PN 14).* Another participant said that physical activity helps her to clear her mind of bad thoughts: *"When I go for a walk, I get rid of my bad thoughts and get new good thoughts. This is why I go for a walk each day at least for an hour […], this is sport and thinking combined." (PN 2).* Quite similar to the previous quote, one participant elaborated on how physical activity might help her to improve her sleep quality: *"I would do that [physical activity] to improve my emotional well-being. I believe it [physical activity] would help me to follow a more positive daily routine and consequently that might help me to improve my sleep quality." (PN 15).*

3.2.3 Self-determination

Another topic participants were eager to elaborate on was their desire to maintain self-determination. A female participant stated that it is important to engage in physical activity in order to stay independent: *"[…] Well, you will do that [physical activity], especially when you live alone and know that you need to maintain agility and mobility or otherwise stumble into dependency." (PN 8).* A male participant had a similar perspective on physical activity. He was more detailed on his outcome objective and stated that he wanted to continue to work after retirement age: *"My goal is to stay healthy, with respect to physical and cognitive condition. It might be that I resume working in a year. I am 64 now. If so, I could work as much as I want and earn as much money as I want. Therefore, health is my top priority." (PN 4).*

3.2.4 Social participation

Besides health outcomes and self-determination, which seemed important to participants, nearly all participants expressed their desire to maintain capabilities to participate in social life. In general, participants emphasized participation with friends and family. A male participant responded to a question about his motivation to engage in physical activity: *"The view at my children, my grandchildren, and my wife of course. I want to keep participating. That is my motivation for physical activity." (PN 1).* A female participant elaborated on her desire to undertake another trip with her best friends and that they motivate themselves to stay active in order to achieve that goal: *"Doing another trip with my girls. We used to travel together every year, but for 2 years now we couldn't, due to injuries and diseases. Realizing such a trip together again is what drives us to be physically active." (PN 10).* Another participant emphasized that health is a prerequisite to maintain the possibility to interact with social contacts: *"This [social contacts] is of major importance [...]. I live alone but I meet my friends very often. When I imagine that I would not be able to leave the house anymore, this would mean a complete change for me, I would not stay there then. I probably would have to move to a senior home [expresses that he is not eager to do that]. Therefore, social participation is an important aspect with respect to physical and mental health." (PN 8).*

3.2.5 Social support

According to our qualitative results, another important indicator promoting physical activity in older adults seems to be social support. Many interview participants implied that support from their social environment plays a major role when deciding for or against physical

activity. A female participant narrated how she motivated a friend to engage in physical activity: *"I had to bolster her. You know she has some health problems and this is why I tried to talk her into regular walking. We now go walking together on a regular basis." (PN 7).* A male participant talked about his family that supports him to be physically active and how this motivates him: *"yes, yes of course. They [family] will know it at first, when I engage in physical activity. I tell them immediately. Their feedback definitely would and could motivate me to be more active." (PN 13).* Another male participant indicated that his wife is very interested in physical activity and for that reason, he learns a bit about it as well: *"It [physical activity] is interesting and you never know what problems and diseases you will face with age. […], my wife is much more interested in it [physical activity] than me. Thanks to her I get to know it [physical activity] better." (PN 4).*

3.2.6 Being active with others

Finally, interview participants implied that the possibility to engage in physical activity with others is an important factor for their motivation. In that context, a female participant mentioned that she does Nordic walking together with her husband: *"I am doing Nordic walking for 15 years now and what I like about it the most is that my husband accompanies me." (PN 2).* Another female participant sees an opportunity in physical activity to interact with and get to know new people: *"Socializing is a result of being physically active, for instance when you have a tennis or golf mate you meet in the morning to play with." (PN 7).* Another participant explains that she would like to do group exercise on a low level: *"I used to be very active you know. I would love to run, but I can't, since it really hurts my muscles.*

I would love to do group exercise on a low level with other people who also suffer from muscular diseases." (PN 15). Competing with others seems to be an additional motivator of being active together for some participants. One participant stated: "*I like the competition. Therefore, I visit the gym. I also exercise alone, but I am not so ambitious then, only doing the necessary exercises. When exercising alone it is very easy to find excuses to stop or not even start the training. When I am at the gym I put more effort in my training, also not to lose my face." (PN 7).*

4 DISCUSSION

Physical activity can improve health and quality of life in older adults (Gillespie et al. 2012; Mercer et al. 2016). However, a positive effect can only be achieved by means of a sufficient exercise dosage and sustainable training with a good adherence over a longer period of time (Phillips, Schneider, and Mercer 2004), and thus the motivation and practices (Wulf et al. 2015) of the participants play an important role. Here, our exploratory study, suggested that HTU in older adults should be disentangled from a technical or device-related perspective. More precisely, we argue that indicators facilitating physical activity engagement in this target group seem to be more relevant predictors for long-term HTU and thus need to find more emphasis in the design of health technologies for older adults.

4.1 Discussion of regression analysis

The regression analysis showed that usefulness, ease-of-use and technology experience were not significant predictors of HTU. This may seem surprising at first since previous research has often underlined the importance of such technology-related factors for HTU (Orruño et

al. 2011; Ammenwerth, Iller, and Mahler 2006). However, at most of these studies, these factors have been examined 'separately', meaning that they were rarely put in models together with SCT or other factors. According to our results, it may be likely that when considering SCT and TAM factors together, social cognitive factors are more relevant to predict HTU in older adults. A reason might be that older adults perceive technologies for AHA support merely as tools supporting their individual change and transformation towards a healthy lifestyle and not primarily as tools to support their physical activity. Such indications and the fact that the variable "expectations regarding physical appearance" in our regression analysis was negatively associated with HTU, are in line with previous research stating that older adults' motivation to lead a healthy lifestyle and exercise is not to look good, but rather feel good (Reboussin et al. 2000). For that reason, health-related expectations was one of the significant predictors in the regression model. Finally, the important role of social support is confirmed by our findings as well, as it has been found to be a significant predictor for HTU (Scarapicchia et al. 2017).

The most surprising finding of the regression analysis is that self-efficacy did not make a significant contribution to our HTU model, despite it being considered as one of the most important predictors for all kinds of behaviors (Amireault, Godin, and Vézina-Im 2013). However, since physical activity was one of the significant predictors and it is known that self-efficacy is crucial for physical activity, it is likely that this indirect relationship explains this finding.

Research has shown that HTU can be a mediator for physical activity (Graham et al. 2014; Rimmer et al. 2004). Interestingly, our results indicate also the opposite way of this

relationship, namely that physical activity, which is known to be influenced by SCT variables like outcome expectations, social support, barriers or self-efficacy (Anderson et al. 2006; Plotnikoff et al. 2013; Anderson, Winett, and Wojcik 2007), may be a mediator for HTU in older adults.

4.2 Implications for the design of AHA technologies

Quantitative and qualitative results in this study provide implications that may facilitate the integration of technology supported physical activity in older adults' daily life and thus create opportunities for long-term use. The following list summarizes the derived implications, which are mostly in line with findings from previous studies:

- AHA technologies should allow older adults to set individual meta goals. Meta goals should be associated with real life contexts, worth working towards to, for instance upcoming journeys or improved sleep quality (Hall et al. 2010; Locke and Latham 2002).
- AHA technologies should provide support functionalities for friends and family members of older adults. Such functionalities could contain buddy systems, where friends or family members encourage the user to be more active or to achieve set goals. Furthermore, older adults could share results or demand more support from friends and family (Goldberg and King 2007; Kahn et al. 2002).
- A certain degree of competition should be encouraged by AHA technologies. For instance, high score rankings to compare with others or daily challenges to motivate older adults to stick to physical activity (Locke and Latham 2002).

- Social aspects in physical activity are of utmost importance for older adults. AHA technologies should embed their training programs in social contexts, for instance physical activities that end in socializing events like communal cooking or community cafes or vice versa, where older adults can share their experiences, exchange information and connect with people of the same age or with similar interests. Therefore, AHA technologies should provide functionalities to bring older adults with same (physical activity) interests together. (Thraen-Borowski et al. 2013; Guedes et al. 2012).

However, the design implications presented in this paper contribute to a more subtle and complete understanding of the factors that motivate older adults to engage in technology-supported physical activity over long. Both, our regression analysis and qualitative analysis came to similar results suggesting a theory in which socio-cognitive factors like social support, social participation or the social environment in general are stronger involved in the decision process of older adults to engage in physical activity than technical or device-related factors. In fact, our theory suggests that technical factor do not at all play a significant role when socio cognitive factors enter the field.

Considering that theory from another perspective, shortcomings in developing technologies for sustainable technology-supported physical activity engagement in older adults might be explained by the way we interpret AHA technologies and their purpose for older adults. Most of the commercially available sensor-based health technologies intend to support older adults to be more active by monitoring their activity levels, reminding them to start training sessions, or providing recommendations on how to improve their physical

activity behaviour. Following technological mediation theories by Ihde, Selinger and Verbeek, the focus of AHA technologies lies mainly on mediating older adults' actions and perceptions with respect to a healthy behaviour (Ihde 1990; Verbeek 2010; Ihde and Selinger 2003). Technological artefacts influence how things are revealed to the user, affecting their perceptions and actions, which shape their intention to act. Through this mediation certain perceptions and actions are amplified, while others are reduced (Ihde 1990; Verbeek 2010; Ihde and Selinger 2003). In the context of HTU, AHA technologies aim to amplify for example older adults' capabilities for efficient and effective physical activity and influence them towards a healthy behaviour, while at the same time aim to reduce their desires for unhealthy behaviour. However, older adults' intentions to engage in physical activity do not necessarily coincide with proposed concepts of available sensor-based health technologies, which primarily lay focus on physical health outcomes. Our study results and scientific literature illustrate that physical health is only one relevant outcome dimension for older adults to engage in physical activity. This dimension is, without questioning and in accordance to our results, important to older adults and probably is the main reason for them to start being physically active in the first place. Nonetheless, their motivation to continue physical activity over long decreases quickly, and it seems a major reason is the insufficient consideration of social environments and motives of older adults. In fact, many technologies for AHA support even interfere with social environments and motives of older adults, when pushing them to be more active by causing guilty conscience. Such concepts might work in the beginning, when motivation is still high. At some point however, older adults may feel impeded in their quality of life, as these technologies and concepts do not integrate well in

their lives, conflict with their social environment and social desires and start to demotivate, when focusing on physical activity and health outcomes only.

Therefore, our study suggests that there is a need for health platforms that provide an integrative perspective on different health domains, for instance physical activity, nutrition, cognition, sleep and social domains. Such platforms may combine different health devices from different domains and adjust their functionalities and health data analyses to social contexts and motives of older adults. Even though, existing literature as well as our study results support the need for integrative approaches in technology-supported physical activity, only few concepts exist that consider focus on the needs of older adults (Barnett et al. 2015; Marcotte et al. 2015). To the best knowledge of the authors, most of these platforms only address health outcomes and neglect the involvement of older adults' social environments.

4.3 Limitations

Although this study provides useful information regarding the factors influencing HTU and the importance of physical activity as a mediator, we have to acknowledge study limitations. First, the sample size for the quantitative part of the study is rather small and therefore the results of the regression analysis must be interpreted with caution. However, to our knowledge, this is one of the very few studies that have compared the relative contribution of parameters from the TAM and the SCT together for HTU and therefore the trends, which are to be seen in this data can be used as a base for future research questions. Secondly, as mentioned in the methods section, there were two study arms with different samples, which also differed somewhat in age and gender ratios, therefore the results of both studies cannot

be generalized for other populations. Ideally, the same participants who have completed the questionnaire should have been interviewed in order to be able to match better the results of the two approaches. However, we aimed to explore the attitudes of participants who already made use of health-technologies and although doing that via an online platform ensured such, the survey was anonymous and therefore we were not able to further contact these participants and invite them for the additional interview sessions. Lastly, this study did not apply objective assessments, but instead relied only on subjective report of the parameters analyzed (HTU and physical activity). This can potentially introduce bias, especially when applied with older adults, as they are prone to over-/underestimations.

5 CONCLUSION

Much research and resources have been invested in the development of sensor-based health technologies to support AHA such that most of them currently not only provide reliable and valid monitoring but they also have a very sophisticated design, which is attractive to most users. However, it seems that design and functionalities of such devices are only key to users who already are motivated to follow a healthy lifestyle and have integrated such healthy behaviors into their daily routine. People who are on the verge of making a lifestyle change and seek support for such a purpose, like for example older adults, use AHA technologies as a tool towards this transition. Therefore, integrating AHA technologies into daily life routines and social environments seems to be much more important to older adults than perceiving for instance good usability or physical activity support functionalities. Aspects such as training together with others, pursuing real life goals or involving family and friends into physical activities are just a few examples in this context provided by participants in our

study. Technologies for AHA support need to address such differencing desires and motives of older adults. Our results suggest that research and industry should prioritize the design and development of health platforms that enable an integrative perspective on health, including social aspects. Therefore, the integration of available AHA technologies into one platform and the alignment of their functionalities to attitudes, practices and motives of older adults may be key for the support of a successful transition towards a healthy lifestyle by means of physical activity. Finally, research should further explore the role of TAM and SCT parameters in HTU as well as the role of physical activity as a mediator in this relationship.

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