SUSTAINED ADOPTION OF SYSTEMATIC PHYSICAL ACTIVITY FOR YOUNG ELDERLY – A DEVELOPED UTAUT APPROACH

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Abstract Health recommendations state that for young elderly systematic physical activi-ties at moderate intensity for at least 150 minutes per week are required to help them stay in good shape for their senior years. We have found that young el-derly readily gets started with a physical activity (PA) program but there is some challenge to make them stay with this program. We have learned that a PA program should build on activities that users find meaningful and/or best suit-ed for their history of PA and their present physical capacity. Support from dig-ital services to find meaningful and suitable programs can make a difference. We work out developments of the UTAUT to find drivers that could help build a sustained adoption of PA programs and propose a model for Systemat-ic Physical Activity Programs (SysPAP).

Keywords: physical activity programs, digital service support, UTAUT, young elderly, sustained adoption.

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1 Introduction

Health care professionals have worked out (THL, 2019a) a recommendation that adults need a minimum of 2.5 hours of moderate physical activity (PA) per week to stay healthier. Higher intensity and/or longer duration give more effect than lower intensity and/or shorter duration. The activities should form a weekly program in order to become a routine or a habit that would be sustained for months and years. A sustainable PA program is key to get long-term health effects. Despite this, PA among Finnish adults is way too low. The ATH 2010-2017 study in Finland (THL, 2019a) shows that in the age group of 30-54 years, only 30% spent several hours per week in PA-programs and in the 55-74 age group, it decreases to 15%. In the 75+ age group only 7% are active for several hours. Moreover, a recent FinHealth2017 study (THL, 2019b) found that 39% of men and 34% of women in Finland reach the recommended levels of PA. The FinHealth2017 study forms a representative sample for the Finnish population. The material is extensive and subsets of it are presented in Tables 1-3.

Table 1: Physical activity, leisure time, proportion of age group (FinHealth2017).

Physical activity, leisure time						
	50-59	**60-69**	**70-79**	**80+**		
No physical activity (%)	28.5	25.4	29.7	48.6	**M**	**25.8**
	26.8	23.9	36.4	73.2	**F**	**29.5**
Light physical activity (%)	44.6	55.0	50.1	37.9	**M**	**40.1**
	50.3	56.2	47.6	22.8	**F**	**44.3**
Fitness physical activity (%)	25.9	19.3	20.0	13.5	**M**	**29.8**
	22.5	19.6	16.1	4.1	**F**	**25.8**
Active sports (%)	1.0	0.3	0.2	0.0	**M**	**4.3**
	0.3	0.3	0.0	0.0	**F**	**1.1**
Sitting (with smart devices (min/day))	172	216	222	206	**M**	**192**
	156	206	223	222	**F**	**174**

In Table 1, we have extracted age groups 50-59, 60-69, 70-79, and 80+ from the material. The table shows the proportion of participants at different PA levels for different age groups as well as the differences between male (**M**) and female (**F**) participants; the last column shows the weighted averages over all age groups (also including 18-29, 30-39, and 40-49). "Light PA" gives little long-term health effects, "fitness PA" is according to health recommendations, and "active sports" represent athletic and competitive activities. The last row shows minutes/day of sitting during

leisure time, which is a source for worries among health care professionals (THL, 2019b).

Our target group is the young elderly (60-75 age group), for which the recommendation is to spend a minimum of 150 minutes/week at moderate PA in order to stay healthier in senior years (Jonasson, 2017).

Table 2: Physical activity, leisure time, following health recommendations (FinHealth2017).

Physical activity, re health recommendations						
	50-59	**60-69**	**70-79**	**80+**		
No physical activity (%)	20.2	19.2	17.5	28.0	**M**	**16.5**
	12.2	11.9	23.8	38.9	**F**	**13.2**
Light physical activity (%)	16.0	21.6	27.4	40.8	**M**	**14.7**
	13.1	24.0	23.2	37.7	**F**	**15.5**
Some brisk, some vigorous (%)	16.0	14.6	14.3	7.3	**M**	**13.6**
	22.1	20.4	18.3	9.1	**F**	**19.8**
Endurance, recommendations (%)	17.4	15.8	12.0	10.6	**M**	**16.5**
	19.6	15.3	14.2	5.5	**F**	**17.4**
Endurance, strength, > 2 days (%)	30.3	28.8	28.8	13.3	**M**	**38.7**
	33.0	28.4	20.5	8.8	**F**	**34.1**

In Table 2, where the PA is registered in relation to health recommendations ("brisk" = "moderate"), the last two rows show PA that combines endurance activity with strength training and in which the activity is distributed over more than two days/week. In the 50-59 age group, 30.3% of the male and 33.0% of the female participants met the recommendations; for the 70-79 age group, this is down to 28.8% and 20.5%, respectively. The weighted average for all age groups is 38.7% (**M**) and 34.1% (**F**).

Physical wellness comes from physical exercise to build stamina, muscle strength, and balance, and to ward off age-related serious illness. Sustained physical exercise helps to meet everyday requirements of life. Studies (Jonasson, 2017; Wallén et al., 2014) show that systematic PA contributes to good quality of life in senior years. In our field work, we have found out that typical forms of exercise of young elderly include walking, running, Nordic walking, gym training, group training, skiing, bocce, dancing, and swimming. The FinHealth2017 study found that the most

popular forms of PA were the same; here we have extracted the PA forms most favoured among the young elderly (Table 3).

Table 3: Physical activity, leisure time, several times/week (FinHealth2017).

Physical activity, several times/week, summer						
	50-59	**60-69**	**70-79**	**80+**		
Yard, garden work (%)	18.8	30.1	35.6	25.7	**M**	**19.0**
	37.7	45.4	42.9	36.1	**F**	**31.4**
Walking, stairs (%)	64.5	56.6	53.0	54.4	**M**	**65.4**
	69.8	59.1	52.6	42.8	**F**	**67.0**
Walking, Nordic walk (%)	48.9	57.2	58.2	60.2	**M**	**53.9**
	69.0	71.9	63.0	52.9	**F**	**69.1**
Bicycling (%)	22.6	24.6	19.8	21.4	**M**	**27.6**
	42.4	33.6	31.9	18.2	**F**	**36.0**
Gym, strength training (%)	12.1	8.4	9.1	6.6	**M**	**19.3**
	8.6	7.5	2.6	1.8	**F**	**13.6**
Cross-country skiing, winter (%)	8.3	10.2	11.1	5.9	**M**	**8.6**
	6.1	7.2	3.6	1.9	**F**	**4.1**
Gym, strength training, winter (%)	15.3	9.9	12.6	2.6	**M**	**21.1**
	13.7	9.6	5.4	4.0	**F**	**16.5**

The most favoured forms of PA are walking, Nordic walking, and yard or garden work. Additionally, one of the most favoured activities is the choice to walk the stairs. Gym and strength training are much less favoured.

The FinHealth2017 study offers several insights for the young elderly age group: (i) the proportion that carries out PA according to health recommendations should be much higher; (ii) PA carried out several times per week should be of sufficient intensity and duration (at least 150 minutes/week at moderate or 75 minutes/week at vigorous intensity); (iii) time spent sitting should be reduced. The 2011 Compendium of Physical Activity (CPA) (Ainsworth et al., 2011) quantifies the energy cost of 821 specific activities in terms of the metabolic equivalent of task (MET). This offers support for dealing with (i) and (ii). METs show the energy cost (effort) of a PA relative to sitting (Ainsworth et al., 2011). It is an objective figure and can be useful for goal setting (e.g., MET-minutes/week) as well as for registration and follow-up of PAs.

In our ongoing research program, young elderly participate in groups to design PA-programs, find ways to implement them with digital services, and to get the digital service technology accepted. Currently there are more than 660 participants in the program. The underlying *research problems* have a wider scope:

- Will the PA programs, with the support from digital services, be adopted and used by the young elderly user group?
- What factors or drivers can help to sustain adoption of PA programs, so that they become a habit or a routine?
- Will these routines help young elderly to continue with PA programs for health effects also in their senior years?

In section 2, we present the composition of PA programs and digital services. In section 3, we introduce variations of the UTAUT (Venkatesh et al., 2012) framework. In section 4, we propose a new framework that will describe, explain, and guide the adoption of systematic PA programs. Finally, section 5 is a summary and offers some solutions to the research problem.

2 Physical Activity Programs and Digital Services

An efficient way to make the adoption of a PA program sustainable, that is, to make participants continue for months or even years, would be to build on selections of activities (cf. Figure 1). These should fit a young elderly participant, his/her PA history, and his/her physical fitness. The CPA (Ainsworth et al., 2011) offers a basis for designing PA programs. The intensity of a PA follows three classes – *light*, *moderate,* and *vigorous* – and is measured with METs (Ainsworth et al., 2011). The health recommendations (THL, 2019a; Bangsbo et al., 2019) correspond to roughly 500 MET-minutes per week, which will give short- and long-term health effects.

Digital services (in the form of smartphone apps with links for storing PA data on a secure cloud service) are useful for getting people started with PA programs (Carlsson and Walden, 2018) and should also work for building sustainable weekly PA programs. It should be easy to record activities, to find MET-minutes and if weekly goals have been met. Summaries show progression over weeks and months to verify that the PA programs contribute to improved PA.

In the research program, we initially used a list of 35 physical activities including their MET values (cf. Figure 1 for a subset).

Activity	CPA METs		
	Low	Moderate	High
Basketball	4,5	6,0	8,0
Soccer	4,9	7,0	10,0
Swimming	3,5	6,0	9,8
Aquajogging	2,5	4,5	6,8
Cross-country skiing	6,8	9,0	12,5
Jogging	6,0	7,0	8,0
Walking	2,8	3,5	4,3
Running	6,0	8,0	9,8
Nordic walking	3,4	4,8	6,8
Golf	3,5	4,8	5,3
Gym training	3,5	5,0	6,0
Orienteering	6,8	9,0	11,0
Cycling	6,8	8,0	10,0
Cycling indoors	4,8	7,0	8,8
Yard work	3,0	4,0	6,0
Other acticity	4,1	5,6	7,5

Figure 1: List (subset) of physical activities, including MET values.

The first set of developed digital services consisted of a smartphone app that supports the logging and reporting of PA (cf. Figure 2). To log a PA, a user selects the form and intensity of the activity, selects the date, and enters the duration; the app responds with the energy expenditure in MET-minutes and kcal. The app sends the data to a secure cloud server (operated by the Social Insurance Institution of Finland) where the participants appear only by pseudonym. The data is used to give weekly, monthly, and yearly reports to make it easy to monitor the progress relative to the user's personal goals.

Drivers for the adoption of digital services have been identified and studied (Yuan et al., 2015) in the context of wellness apps. The drivers for the intention to continue using the apps come from the UTAUT2 model (Venkatesh et al., 2012). They include (summarised from Yuan et al., 2015): (i) performance expectancy ("degree to which the use of a technology will help users to perform chosen activities"); (ii) effort expectancy ("degree of ease in the use of a technology"); (iii) social influence ("perception that important others support the use of technology"); (iv) facilitating

conditions ("factors that facilitate or impede adoption of technology"); (v) hedonic motivation ("fun or pleasure with using a technology"); (vi) price value ("trade-off between perceived benefits of and monetary cost for using a technology"); (vii) habit ("perception of automatically engaging in a certain behaviour").

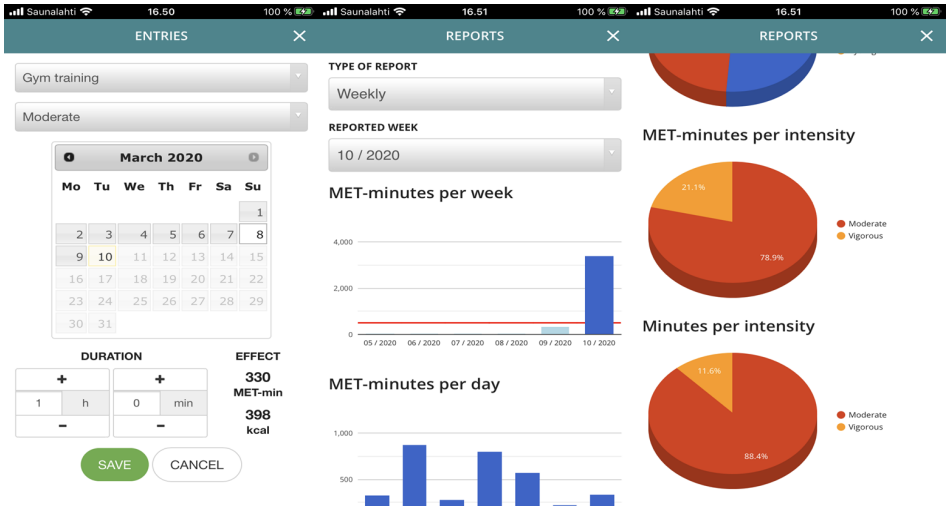

Figure 2: Logging and reporting of activities.

The UTAUT2 addresses the acceptance and use of information technology. *Digital services* are information technology by common understanding – they are delivered via the internet or an electronic network, they are automated, and they typically require little or no human intervention.

3 UTAUT and Its Variations

In (Reyes-Mercado, 2018), it was found that performance expectancy and effort expectancy have high net effects on the use and intention to use for adopters of fitness wearables. The study by Alshare-Mousa (2014) works out the intention to use mobile payment devices and adds a few interesting constructs. It finds that performance expectancy, social influence, and perceived information security are significant drivers of a consumer's behavioural intention. It also found uncertainty avoidance, masculinity, and collectivism to have moderating effects. A study of how students use social networking sites (Borrero et al., 2014) confirms that effort expectancy, social influence, and performance expectancy are key drivers.

Technology readiness (TR) had a moderating effect on the drivers, especially on effort expectancy among female students and students with self-reported low-level TR. Male students and students with self-reported high-level TR showed moderating effect on social influence. Knowledge management systems have specific benefits and challenges. When studied with the UTAUT framework, Bourdon-Sandrine (2009) found performance expectancy and social influence to act as drivers of the intention to use. The found facilitating conditions were novel: organizing structure, available time, time allocated, and incentives.

An integration of theories from collaboration research (i.e., social presence theory, channel expansion theory, and the task closure model) with UTAUT offers an interesting basis for work with collaboration technology (Brown et al., 2010). This proposes that collaboration technology features, individual and group characteristics, task characteristics, and situational characteristics are predictors of performance expectancy, effort expectancy, social influence, and facilitating conditions. The intention to use collaboration technology is moderated by gender, age, and experience.

Chiu-Wang (2008) expanded UTAUT for a study of user loyalty or subsequent continued usage. The added construct was subjective task value, and the results showed that performance expectancy, effort expectancy, computer self-efficacy, attainment value, utility value, and intrinsic value were significant predictors of intentions to continued use, whereas anxiety had a significant negative effect. UTAUT was used as the framework for a study of system use in Facebook, which is a hedonic volitional setting (Lallmahomed et al., 2013). A novel result was that hedonic performance expectancy is significantly related to cognitive absorption. Another result was that the user/task aspects better explain Facebook use than the system/task aspects, i.e., what the user wants to achieve is a stronger driver than the technical capabilities of the system. The study by Neufeld et al. (2007) represents a classical UTAUT setting – a large-scale IT implementation in an organisation. The novel factor is project champion charisma, which was found to be positively associated with increased performance expectancy, effort expectancy, social influence, and facilitating condition perceptions of users.

Conventional technology acceptance models do not offer any good understanding of behaviour related to internet services (Oh-Yoon, 2014). The authors found that modifying the UTAUT by adding the concepts "trust" and "flow experience" they could find better explanations for behavioural intention towards internet services (e-learning and online gaming). An early modification of the UTAUT framework offers some modified constructs (Venkatesh et al., 2008). Behavioural expectation replaces behavioural intention and facilitating conditions. System use is classified in terms of duration, frequency, and intensity. Age, gender, and experience moderate the impacts of facilitating conditions on behavioural expectation: experience moderates the impacts of behavioural intention and behavioural expectation on use. The first systematic extension and adoption of UTAUT to consumers (Venkatesh et al., 2012) added three constructs: hedonic motivation, price value, and habit. Individual differences in terms of age, gender, and experience moderate the effects of the new constructs on behavioural intention and technology use.

In 2016, Venkatesh et al. worked out a broad synthesis of the UTAUT constructs and numerous modifications and extensions of the original UTAUT framework (cf. Figure 3).

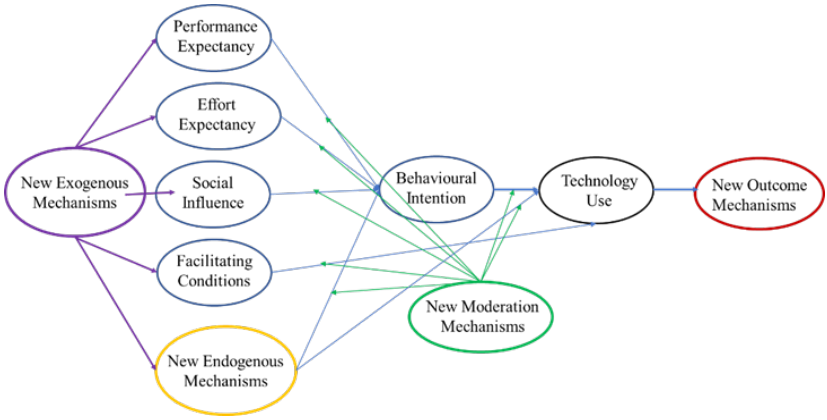

Figure 3: Types of UTAUT extensions (Venkatesh et al., 2016).

The focus was on technology users, not general organisational members. Technology attributes include the overall function and features like usability. Task attributes include task type and stages of the sequence of tasks. The relevant time is defined relative to the implementation of a target technology. The social context of

technology acceptance and use needs to be assessed. The location, physical environment, and conditions need to be specified for where the target technology is introduced, implemented, adopted, and used. Within this broad framework, it is now possible to work out variations of the UTAUT constructs that fit the context, the user groups, and the purpose for which we need to identify drivers for the adoption, adaptation, and use of information technology. The constructs offered by Venkatesh et al. (2016) give many degrees of freedom (cf. Figure 3): "technology use" is a driver of "new outcome mechanisms", which offers interesting opportunities, and there are new "endogenous", "exogenous", and "moderation" mechanisms for which there are candidates in the above overview.

In the next section, we will use the opportunity to propose and try out a few new constructs for digital service support of the implementation, adoption, and use of PA programs for young elderly.

4 Sustained Adoption of PA Programs through Digital Service Support

The FinHealth2017 material shows that the PA levels among young elderly are way too low. Numerous studies (e.g., Wallen et al., 2014; Bangsbo et al., 2019) have repeatedly shown that for young elderly, systematic PA programs contribute to better health in senior years. There is a need for good theoretical frameworks to show and explain how PA programs will be adopted and how the adoption will be sustainable, i.e., the users will stay with the programs for extended periods of time that will give them positive long-term health effects. In the following, we build a storyline that describes how the generic UTAUT framework adapts to the requirements for sustained adoption of PA programs; the storyline is influenced by the elaboration-likelihood model (ELM) first introduced in 1986 by Petty and Cacioppo (cf. Bhattacherjee & Sanford, 2006).

We need a **theory framework** and **models** for describing, explaining, and predicting the acceptance, adoption, and use of systematic PA programs through digital services. The PA programs are systematic weekly programs in a context of young elderly. The theory framework builds (as UTAUT) on commonly used theory instruments (such as the theory of planned behaviour by Ajzen, 1991) but is adapted to the specific requirements of the young elderly context. The models build on

experience with the UTAUT2 framework but use new exogenous, endogenous, and moderation mechanisms found to be relevant for the young elderly context.

There are **endogenous motivations** for young elderly to decide on sustained adoption of systematic PA programs. An often-stated motive is "*to get more good years*", which is a self-evident and strong objective. There are facts, news, and media discussions about the effects of PA on health and the chance to avoid serious illness in senior years. Young elderly have short-term goals to continue with their everyday routines and longer-term goals for plans on activities that require good or better physical shape.

Exogenous motivations for young elderly include physicians' health recommendations on PA programs to deal with diagnosed medical conditions. Public policy decisions on reduction in elderly care and cutdowns in budget costs for the aged population are drivers for young elderly to "*stay in shape, as care may not be available if we need it".*

Social influence is an exogenous factor for systematic PA programs. The strongest influence typically comes from family and loved ones that want to contribute to the "more good years". Young elderly can have peer groups with members in good or better shape that offer inspiration and encouragement, social media peer groups formed around similar PA programs and with similar short- and long-term goals, associations with senior sports activities, including former team-mates and competitors, as well as pensioners' associations with organized PA programs.

Aims for wellness & quality of life are endogenous factors to decide on a sustained adoption of systematic PA programs. Of the individual quality of life features, some have direct and others indirect connections with PA: to be in good physical and mental shape represents wellness; short-term goals for the next few months, e.g., to recover from medical problems; longer-term goals to realize plans in years to come on physical or intellectual projects, travel, new hobbies, major accomplishments, new life styles, or similar.

Behavioural intention for young elderly to decide on sustained adoption of systematic PA programs. This is intention to (i) accept, (ii) adopt, (iii) use, and (iv) continue to use systematic PA programs on a weekly basis (our present approach).

Moderation mechanisms. Age sets physical limitations – intentions may be different in different age groups [60, 65, 70, 75, 75+]. **Physical limitations** presented by BMI – differences in BMI may show in intentions. **Subjective assessment of physical shape** – differences may show in intentions and subjective assessment may differ from objective reality. **History of PA** – PA during the previous 10 years are more important than the nostalgic memories of physical prowess in younger years. **Work history** of physically conditioning activities vs. limited or no PA. **Physically conditioning** leisure activities vs. leisure time with no PA.

Technology use for young elderly to decide on sustained adoption of systematic PA programs. **Digital services** build on ICT infrastructure, architectures for data, information, and knowledge fusion, and systems of applications. **Functionality** that fits the users and their context, derived from a selection of the UTAUT mechanisms, guides the users to digital services. **User interfaces** that can be adapted to and tailored for young elderly users and are self-adaptive to users' cognitive style over time. **Coaching** adapted to and tailored for young elderly users and self-adaptive to users' PA levels and objectives over time. **Gamification** initiates and supports motivation for young elderly to use the digital services and the PA programs. ***Digital coaching*** supports the selection and use of PA programs as well as goal setting and attainment and can be integrated with gamification (cf. Kari et al 2016; Kari & Rinne, 2018). **Feedback reporting** on the fulfilment of (weekly) PA intentions, attainment of PA objectives, and dynamic goal achievement.

Sustained use of PA programs for young elderly can turn into habitual routines ("*settled or regular sequence of actions*"). A selection of systematic (weekly) PA programs for individual users to get actual **MET-min per week**, classified as light, moderate or vigorous; regular vs. irregular; sustained vs. non-sustained. **Subjective assessments** of light, moderate or vigorous; regular vs. irregular; sustained vs. non-sustained in follow-up measurements. **First goal** to reach 500 MET-min per week; consecutive goals through individual goal setting for systematic weekly programs. Testing PA programs for **habitual routines** (habits/routines). Subjective assessments of **short- and long-term effects**. The above listed constructs are summarised as the Systematic Physical Activity Programs (SysPAP) model in Figure 4.

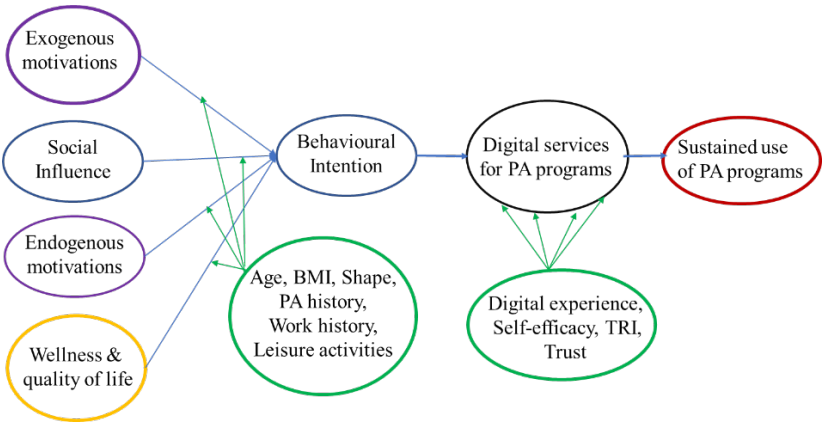

Figure 4: Sustained adoption of systematic PA programs – the SysPAP model.

5 Summary and Conclusions

In this paper, we present a model for Systematic Physical Activity Programs (**SysPAP**). The context of our model is the age segment called young elderly (60-75 years old). Health recommendations state that it is advisable for young elderly to be physically active in order to stay healthier during the senior years. This can be made practical with systematic, weekly PA programs (at moderate intensity for at least 150 minutes per week). The FinHealth2017 data shows that only about 28% of the young elderly reach this level and that significant action is required to get them to adopt routines that can contribute to healthier senior years. In our on-going research program, we aim to develop systematic PA programs and support them with digital services to make them accessible, easy to use, and motivational for young elderly. In our field studies (Carlsson and Walden, 2018, 2019) we have found that users get started with PA programs but do not stay with them. A PA program should build on activities that users find meaningful and best suited for their present physical capacity and PA history. Digital services can make a difference. The UTAUT framework is a good starting point for key constructs and drivers to reach sustained adoption of PA programs. We worked out a development of the UTAUT called SysPAP to find the drivers that could explain how young elderly adopt and stay with PA programs.

Obviously, the next step is to validate the SysPAP model empirically among the young elderly users. For this task, we have about 660 participants in our research program (at the moment). Both, cross-sectional and longitudinal studies are planned. The following step is to compare the SysPAP and the UTAUT2 frameworks for descriptive precision, for partial explanation, and for possible prediction.

References

Ainsworth, B.E. et al. (2011). 2011 Compendium of Physical Activities, 0195-9131/11/4308-1575/0, Medicine & Science in Sports & Exercise, DOI: 10.1249/MSS.0b013e31821ece12

Ajzen, I. (1991). The Theory of Planned Behavior. Organizational Behavior and Human Decision Processes, 50(2), 179-211.

Alshare, K., Mousa, A. (2014). The moderating effect of espoused cultural dimensions on consumer's intention to use mobile payment devices. In Proceedings of the 35th International Conference on Information Systems (pp.1-15)

Bangsbo, J. et al. (2019). Copenhagen Consensus statement 2019: physical activity and ageing, Br J Sports Med 2019;0:1–3. doi:10.1136/bjsports-2018-100451The 2011 Compendium of Physical Activity

Bhattacherjee, A., Sanford, C. (2006). Influence Processes for Information Technology Acceptance: An Elaboration Likelihood Model, MIS Quarterly, Vol.30, No.4, 805-825

Borrero, J. D., Yousafzai, S. Y., Javed, U., Page, K. L. (2014). Expressive participation in internet social movements: Testing the moderating effect of technology readiness and sex on student SNS use. Computers in Human Behavior, 30, 39-49.

Bourdon, I., Sandrine, O. (2009). Towards an understanding of knowledge management systems: UTAUT revisited. In Proceedings of the 15th Americas Conference on Information Systems (pp. 1-13). San Francisco, CA.

Brown, S. A., Dennis, A. R., & Venkatesh, V. (2010). Predicting collaboration technology use: Integrating technology adoption and collaboration research. Journal of Management Information Systems, 27(2), 9-53.

Carlsson, C., Walden P. (2018). Digital Wellness Services: Key to Better Quality of Life for Young Elderly, Andreja Pucihar et al. (editors), Proceedings of the 31st Bled eConference, Bled 2018, pp 248-261.

Carlsson, C., Walden, P. (2019). Digital Support to Guide Physical Activity – Augmented Daily Routines for Young Elderly, Andreja Pucihar et al. (editors), Proceedings of the 32nd Bled eConference, Maribor 2019, pp 783-802.

Chiu, C. M., & Wang, E. T. G. (2008). Understanding web-based learning continuance intention: The role of subjective task value. Information & Management, 45(3), 194-201.

Hukkanen, H., Husu, P., Sievänen, H., Tokola, K., Vähä-Ypyä, H., Valkeinen, H., Mäki-Opas, T., Suni, J.H., Vasankari, T. (2018). Aerobic physical activity assessed with accelerometer, diary, questionnaire, and interview in a Finnish -population sample, Scandinavian Journal of Medical Science in Sports, 2018;28:2196–2206, https://doi.org/10.1111/sms.13244

Jonasson, L. (2017). Aerobic Fitness and Healthy Brain Aging. Cognition, Brain Structure, and Dopamine, Doctoral Dissertation, Umeå University

Kari, T., Piippo, J., Frank, L., Makkonen, M., Moilanen, P. (2016). To gamify or not to gamify? gamification in exercise applications and its role in impacting exercise motivation. In Proceedings of the 29th Bled eConference "Digital economy", pp. 393-405. University of Maribor, Bled, Slovenia.

Kari, T., Rinne, P. (2018). Influence of digital coaching on physical activity: motivation and behaviour of physically inactive individuals. In Proceedings of the 31st Bled eConference "Digital Transformation – Meeting the Challenges", pp. 127-145. University of Maribor Press, Bled, Slovenia.

Lallmahomed, M. Z. I., Ab Rahim, N. Z., Ibrahim, R., & Rahman, A. A. (2013). Predicting different conceptualizations of system use: Acceptance in hedonic volitional context (Facebook). Computers in Human Behavior, 29(6), 2776-2787

Neufeld, D. J., Dong, L., Higgins, C. (2007). Charismatic leadership and user acceptance of information technology. European Journal of Information Systems, 16(4), 494-510.

Oh, J. C., Yoon, S. J. (2014). Predicting the use of online information services based on a modified UTAUT model. Behavior & Information Technology, 33(7), 716-729.

Petty, R.E., Cacioppo, J.T. (1986). Communication and Persuasion: Central and Peripheral Routes to Attitude Change. Springer-Verlag, New York

Reyes-Mercado P. Adoption of fitness wearables. Insights from partial least squares and qualitative comparative analysis, Journal of Systems and Information Technology, Vol. 20 No. 1, 2018, pp. 103-127

THL – Finnish Institute for Health and Welfare. 2019a. Aikuisten terveys-, hyvinvointi- ja palvelututkimus, ATH 2010-2017.

THL – Finnish Institute for Health and Welfare. 2019b. National FinHealth Study.

Wallén, M. B., Ståhle, A., Hagströmer, M., Franzén, E. & Roaldsen, K. S. (2014), Motionsvanor och erfarenheter av motion hos äldre vuxna, Karolinska Institutet, Stockholm, March 2014

Venkatesh, V., Brown, S. A., Maruping, L. M., Bala, H. (2008). Predicting different conceptualizations of system use: The competing roles of behavioral intention, facilitating conditions, and behavioral expectation. MIS Quarterly, 32(3), 483-502.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. MIS Quarterly, 36(1), 157-178.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2016). Unified Theory of Acceptance and Use of Technology: A synthesis and the Road Ahead. JAIS, Vol 17, Issue 5, 328-376

Yuan, S., Ma, W., Kanthawala, S., Peng, W. (2015). Keep Using My Health Apps: Discover Users' Perception of health and Fitness Apps with the UTAUT2 Model, Telemedicine and e-Health, Vol.21, No.9, 7335-741