

SMART VITAALITY – EFFECTS OF A MODULAR AAL SYSTEM ON SUBJECTIVE QUALITY OF LIFE. METHODS AND MAIN RESULTS

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ABSTRACT: Gerontechnologies have the potential to contribute to a good life in old age by minimizing age-related losses and maximizing gains. However, the evidence for the assumed positive effects on subjective quality of life (sqol) is low, inter alia, due to methodological limitations (e.g. lack of controlled studies) and a lack of theory-based development and evaluation processes. Thus, the present quasi-experimental study (bmvit: benefit, project number: 858380) seeks to add to this research base. The effects of a modular but individually combinable AAL-system on sqol were investigated in a comparatively large sample of community dwelling older adults. Propensity score matching was used to control for selection bias due to non-random group assignment. Participants' sqol was assessed before and after the one-year intervention phase using standardized scales. Primary outcomes were analyzed based on a modified intention-to-treat approach. Data were analyzed using two-way mixed analysis of variance (ANOVA), with group as between-subjects variable and time as within-subjects variable. Only for one sub-scale, social relationships, a significant group x time interaction was observed. Taken together, positive effects of the modular AAL-system on sqol could not be detected in the present study. Further studies should focus on theory-guided development and selection of technological solutions for older adults.

1 INTRODUCTION

Gerontechnologies have the potential to contribute to a good life in old age if they support coping with age-specific challenges and developmental tasks and are adapted to the individual needs and life goals [5, 11, 12]. According to experts, such technical solutions, e.g., have the potential to increase the feeling of autonomy and safety in users [14]. Furthermore, they might assist older people to strengthen their social relationships or to improve their health management [14].

However, results on the effects of AAL technologies on the subjective quality of life (sqol) are mixed so far [20]. In the Austrian test region ZentrAAL no significant effects on sqol dimensions could be revealed, except for a short-term increase in perceived safety [19]. Furthermore, studies published so far often lack methodological rigor (c.f. reviews conducted by [7, 13, 20]). Although a theory-based approach enables a target-oriented development and/or selection of technologies that are precisely tailored to influence the intended target parameters, technical solutions for older adults are rarely developed theory-driven [7, 13]. Furthermore, there is a paucity of controlled studies and high dropout rates limit the generalizability [13]. In addition, the evaluated technical solutions are very heterogeneous, which makes

generalization even more difficult. As a result, the evidence for assumed positive effects of such quality of life technologies is considerably low, albeit plausible [11].

Therefore, the objective of the present study was to examine the effects of a modular but individually combinable AAL system on sqol dimensions in older people in Carinthia, Austria. Based on the above-mentioned literature, we hypothesized, that participants in the Smart VitAALity condition (vs. control group) would show improvements in relevant sqol dimensions, especially in subjective physical and psychological quality of life, social relationships and participation, and autonomy.

2 METHODS

2.1 STUDY DESIGN

In the present project a nonequivalent controlled pretest-posttest design was employed. In favor of realizing a large sample size, the project leader (third author) decided to address potential study participants either for the intervention or control group. Propensity score matching (PSM) was used to control for selection bias due to non-random group assignment. Data analysis including PSM was performed by the first author with assistance from the second author.

2.2 ELIGIBILITY CRITERIA

Community dwelling older people aged 60 – 85 years or in case of geriatric disabilities aged 55+ years were deemed eligible to participate. People up to care level 4 were eligible as well as people living in one or two-person households, albeit only one person per household could participate. People suffering from severe vision impairments and motor skill impairments with effects on the operability of the technical system were excluded (for details see [16]).

2.3 SAMPLE

The pretest was completed by 230 participants (intervention group: $n = 107$, control group: $n = 123$), the posttest was completed by 221 participants (intervention group: $n = 100$, control group: $n = 121$). As effect estimates are likely to be biased by group imbalance in a non-randomized study, the distribution of covariates was balanced through propensity score matching (PSM, [9, 17]). Using the SPSS R-plugin PSMATCHING3.03 [18], a propensity score was estimated using logistic regression based on a set of 21 theoretically meaningful pre-test covariates with treatment assignment as dependent variable: age, gender, one-person household, care level, four dimensions of technology affinity, and the pre-test sqol scores. Based on the propensity score 1:1 nearest neighbor matching was performed imposing a caliper of .2 of the standard deviation of the logit of the propensity score. The adequacy of the model and the matched sample was carefully assessed following the recommendations of Thoemmes [18]. Good balance was achieved (see figure 1), the standardized mean difference was reduced from $d = .905$ to $d = .083$, the overall χ^2 balance test was also not significant, $\chi^2(21) = 3.288$, $p = 1.000$. As a result, 65 well-matched pairs were identified.

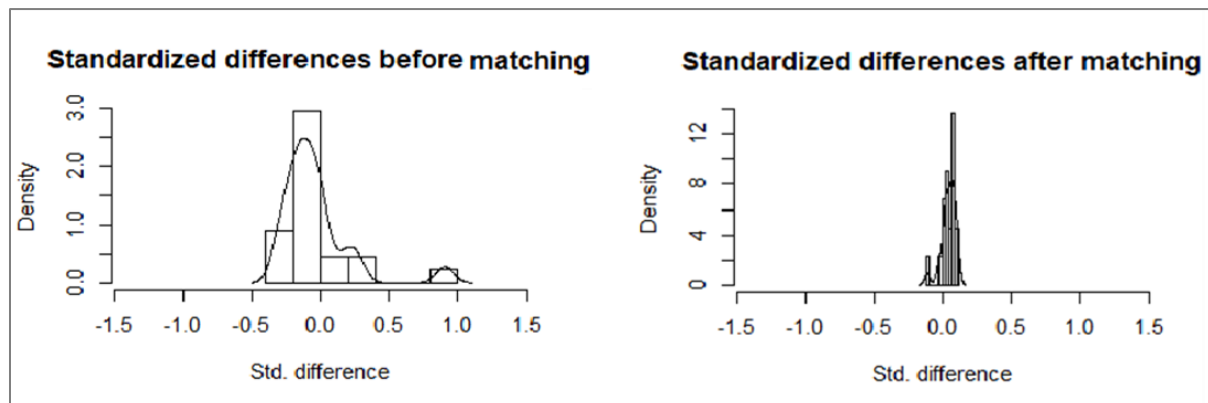


Figure 1: Histograms with overlaid kernel density estimates of standardized differences before and after matching

2.4 SMART VITAALITY INTERVENTION

The Smart VitaALity system is a technological bundle consisting of modern communication and information technologies and measuring devices for recording vital parameters. Community dwelling older people in the intervention group received a smart watch, a tablet, a scale, and a blood pressure monitor (for a detailed description see [16]). The smart watch and the tablet computer are the two devices by which active human-machine interactions could be carried out. The tablet computer in particular serves as a digital base station for recording health data and as a platform for digital networking. The smart watch serves as an add-on as it provides both an emergency call function and lifestyle functions such as a pedometer or a calendar. Furthermore, participants could choose to use the care center. In case of problems with the devices during the field test phase, the participants were able to call a technical support hotline, which was available from Monday to Friday from 8:00 am to 4:00 pm. Participants of the control group did not receive any of the Smart VitaALity devices during the study period, but were provided with technical devices afterwards.

2.5 MEASURES

Well-established scales [4] were employed to measure the relevant sqol dimensions before the intervention started (T1) and after the one-year intervention period (T2). Quality of life was assessed using the WHOQOL-BREF [1], a generic measure of quality of life, comprising four dimensions (physical quality of life, psychological quality of life, social relationships, environment) together with the supplementary module WHOQOL-OLD [1] comprising six facets (sensory abilities, autonomy, past, present and future activities, social participation, death and dying, intimacy), which was developed bottom-up with older adults. Cronbach's α ranges from .65 to .91 across the scales in the present study.

As changes in internal standards can affect outcome assessment, recalibration response shift was assessed at T2 by asking respondents to retrospectively evaluate their subjective quality of life (WHOQOL-BREF item bref 1) and subjective health (WHOQOL-BREF item bref 2) at T1 (then-test [15]).

Martin et al. [8] suggest functional quality of life (fQOL) as an alternative to measuring sqol and objective quality of life. As corresponding scales are yet to be developed, a single item

was used in the present study (“Modern technologies make it easier for me, to perform activities, that are important to me.”), which could be answered on a 5-point rating scale.

The short form of the Social Support Questionnaire (F-SozU-K14 [2]) was used to measure perceived emotional and practical support as well as social integration (Cronbach’s $\alpha = .943$). The HPEAS_{KD} (Hertz Perceived Enactment of Autonomy Scale [21]) was used to measure perceived autonomy (Cronbach’s $\alpha = .801$).

Technology affinity as a potential confounder was assessed using the TA-EG [6] comprising four sub-scales (excitement, competence, positive attitude, and negative attitude) with Cronbach’s α ranging from .69 to .87 across the sub-scales in the present study.

2.6 DATA ANALYSIS

All participants were included in the analysis, regardless of the intensity of use of the technical solutions (modified intention-to-treat analysis [10]). Data were analyzed using two-way mixed analysis of variance (ANOVA), with group as between-subjects variable (Stuart [17] suggests not to account for the matched nature of the data after PSM) and time as within-subjects variable. In particular, we are interested in the group x time interactions, of course. We also explored, if there are advantages for frequent users (tertiles of overall usage). Statistical significance was accepted as $p < 0.05$. Statistical analyses were performed using SPSS version 25.0.

3 RESULTS

Baseline characteristics of the sample after PSM are reported in table 1. In addition, groups are also well balanced for baseline sqol scores (standardized mean differences ranging from Cohen’s $d = .009$ to $-.100$). Participants in both groups reported high baseline sqol and scored significantly higher compared to the norm population [1] on all WHOQOL-BREF and WHOQOL-OLD scales (one-sample t-tests; results not reported due to space limitations).

Table 1: Demographic characteristics and technology affinity (TA-EG) after PSM

Variable	IG (<i>n</i> = 65)	CG (<i>n</i> = 65)	Significance (<i>t</i> -test, Pearson chi-square test, Fisher's exact test)
age, <i>M</i> (<i>SD</i>)	69.4 (6.60)	69.0 (6.42)	$t(128) = -0.323, p = .747$
female, <i>n</i> (%)	44 (67.7%)	47 (72.3%)	$\chi^2 (1, 130) = 0.330, p = .566$
Single-person household, <i>n</i> (%)	28 (43.15)	29 (44.65)	$\chi^2 (1, 130) = 0.031, p = .860$
Care level 0, <i>n</i> (%)	61 (93.8%)	60 (92.3%)	$p = 1.000$
TA-EG excitement, <i>M</i> (<i>SD</i>)	2.9 (0.92)	2.8 (1.04)	$t(128) = -0.411, p = .682$
TA-EG competence, <i>M</i> (<i>SD</i>)	2.6 (0.74)	2.6 (0.78)	$t(128) = -0.086, p = .932$
TA-EG positive attitude, <i>M</i> (<i>SD</i>)	2.1 (0.70)	2.1 (0.65)	$t(128) = -0.391, p = .697$
TA-EG negative attitude, <i>M</i> (<i>SD</i>)	3.6 (0.63)	3.6 (0.73)	$t(128) = -0.256, p = .798$

The results from the two-way mixed ANOVA are illustrated in table 2.

Table 2: Results of two-way mixed ANOVA for sqol outcomes after PSM

Variables	Group (df 1, 128)			Time (df 1, 128)			Interaction (df 1, 128)		
	F	p	η^2_p	F	p	η^2_p	F	p	η^2_p
WHOQOF-BREF									
Physical health	0.172	.679	.001	0.361	.549	.003	0.025	.875	<.001
Psychological health	0.073	.787	.001	1.183	.279	.009	0.518	.473	.004
Social Relationships	0.647	.423	.005	0.006	.941	<.001	4.353	.039	.033
Environment	0.052	.821	<.001	0.035	.851	<.001	0.969	.327	.008
Overall	0.062	.804	<.001	1.885	.172	.015	0.036	.850	<.001
WHOQOL-OLD									
Sensory Abilities	0.797	.374	.006	3.846	.052	.029	0.190	.664	.001
Autonomy	0.510	.476	.004	1.175	.280	.009	3.505	.063	.027
Past, Present and Future Activities	0.179	.673	.001	0.804	.372	.006	0.032	.858	<.001
Social Participation	0.033	.857	<.001	1.566	.2130	.0120	1.002	.319	.008
Death and Dying	0.230	.632	.002	0.022	.882	<.001	0.270	.604	.002
Intimacy	0.009	.927	<.001	0.004	.951	<.001	0.044	.835	<.001
FSozU-K14 and HPEAS _{KD}									
Social Support	0.010	.921	<.001	1.284	.259	.010	0.771	.382	.006
Autonomy	0.019	.892	<.001	2.978	.087	.023	0.855	.357	.007
Single Items									
bref 8: perceived safety ^a	0.119	.731	.001	0.476	.491	.004	0.209	.648	.002
fqol: functionality	1.204	.275	.009	0.903	.344	.007	0.011	.916	<.001

Note: ^a (df 1, 125)

A significant group x time interaction could be revealed for social relationships. Social relationships improved for the intervention group (T1: $M = 72.6 \pm 16.07$, T2: $M = 74.9 \pm 14.87$), but decreased for the control group (T1: $M = 72.3 \pm 21.91$, T2: $M = 70.2 \pm 21.51$; see figure 2a). For autonomy, results are mixed. On one scale we see a marginally significant group x time interaction, with autonomy decreasing slightly in the intervention group from $M = 77.2 \pm 13.54$ at T1 to $M = 76.3 \pm 14.20$ at T2, but increasing in the control group (T1: $M = 76.8 \pm 17.39$, T2: $M = 80.2 \pm 16.07$; see figure 2c). On the second scale, autonomy decreases significantly in both groups (significant main effect of time, see figure 2d). There are no further significant main effects or interaction effects except for a marginally significant main effect of time on sensory abilities (see figure 2b). Also perceived safety (single item) and fqol (single item) remained stable in both groups. Further exploratory analysis dividing the intervention group by the overall frequency of use of the technical solutions (tertiles) did not yield clear advantages for frequent vs. infrequent users (results not reported due to space limitations). There was no significant recalibration response shift (pretest score minus then-test score) for subjective quality of life (sqol), $t(129) = 1.599$, $p = .112$, and a marginally significant recalibration response

shift for subjective health (sh) , $t(129) = -1.699, p = .092$. Intervention group and control group do not differ significantly in the amount of response shift, sqol: $t(128) = -0.106, p = .916$, sh: $t(128) = 0.423, p = .673$, in the observed effects (pretest score minus posttest score) , sqol: $t(128) = -0.111, p = .912$, sh: $t(128) = 0.606, p = .546$, or the adjusted effects (then-test score minus posttest-score), sqol: $t(128) < -0.001, p = 1.000$, sh: $t(128) = 0.235, p = .815$.

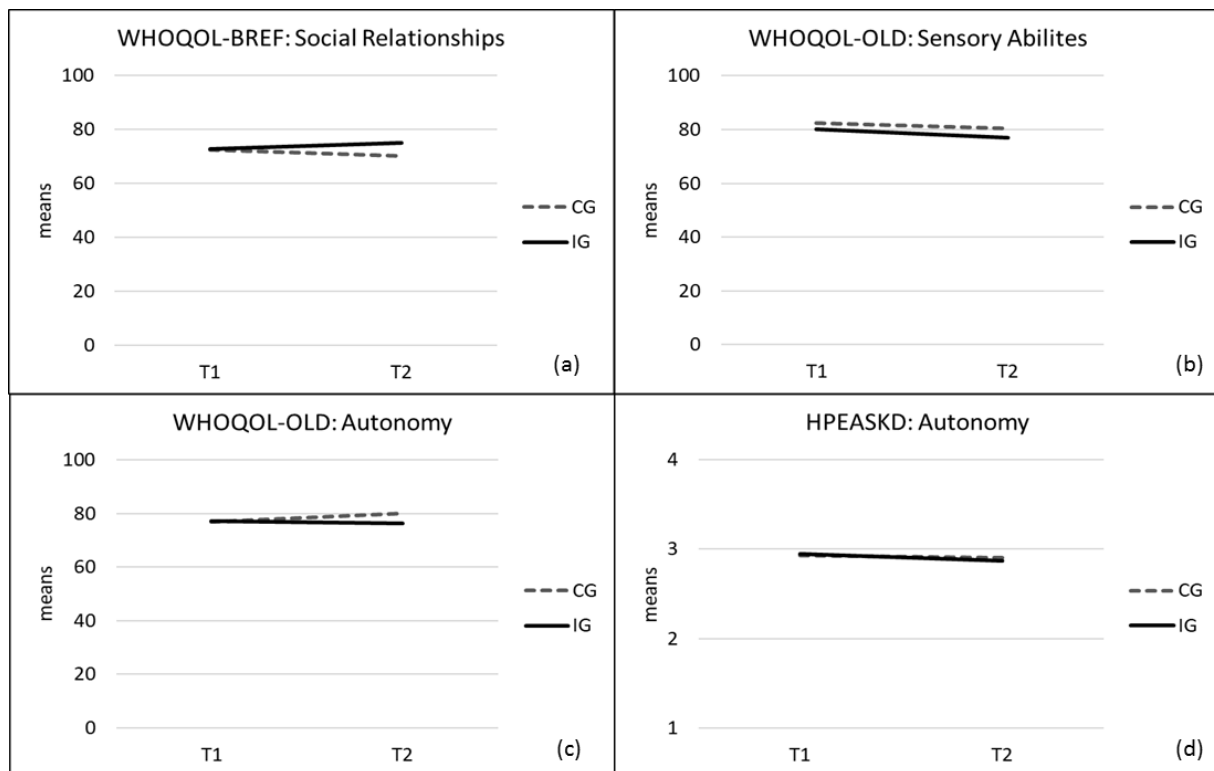


Figure 2: Changes in sqol domains for intervention and control group after PSM

4 DISCUSSION

Taken together, the assumed positive effects of the modular AAL-system on sqol could not be observed in the present study. The same is true for other AAL and benefit studies (e.g., ROSETTA [3], ZENTRAAL [19]). Only on one scale a significant group x time interaction could be revealed. Social relationships improved for the intervention group, but not for the control group. For WHOQOL-OLD autonomy sub-scale a marginally significant group*time interaction was observed, indicating that the intervention lead to an unintended decrease in autonomy. On the other hand, autonomy measured with the HPEAS_{KD} showed a decrease in both groups, which qualifies the first result. Hence, results regarding autonomy are mixed and difficult to interpret. Exploratory analysis did not reveal advantages for frequent users of the technological bundle. A slight recalibration response shift was observed for subjective health (single item bref 2) in both groups, no such effect occurred for the overall quality of life rating (single item bref 1). Consequently, response shift does not seem to explain why the study failed to detect treatment effects.

Some limitations warrant discussion. Even though good balance between groups was established on a set of covariates using propensity score matching, further covariates not

measured in the present study might still lead to bias. The technological bundle in the present study comprised a large number of different technical solutions, which participants could choose to use according to their different needs and/or interests, making it hard to capture effects. In future studies, the number of technical solutions tested should be reduced in favor of theory-guided development and selection [13, 19]. Further studies based on gerontological theories and knowledge are needed to understand how and under which conditions gerontechnology supports quality life [5].

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