The use of self-monitoring applications for self-management by healthcare consumers

Masterthesis

Physiotherapy Science

Program in Clinical Health Sciences

Utrecht University

Name student:	E. (Eric) Krommenhoek
Student number:	4277902
Date:	June 28, 2019
Internship supervisor(s):	Dr. Ir. M.W.J. Huygens, dr. I.C.S. Swinkels, dr. J.F. de Groot
Internship institute:	Department of Quality and Organization of care and cure, Nivel, Utrecht, The Netherlands
Lecturer/supervisor Utrecht University:	Dr. M.F. Pisters

"ONDERGETEKENDE

Eric Krommenhoek

bevestigt hierbij dat de onderhavige verhandeling mag worden geraadpleegd en vrij mag worden gefotokopieerd. Bij het citeren moet steeds de titel en de auteur van de verhandeling worden vermeld."

Examiner

Dr. M.F. Pisters

Assessors:

Dr. Ir. M.W.J. Huygens

Dr. J. van der Net

Masterthesis, Physical Therapy Sciences, Program in Clinical Health Sciences, Utrecht University, Utrecht, 2017

ABSTRACT

Background: From the perspective of the increasing number of chronically ill people, the increasing shortage of healthcare professionals and the rising healthcare costs, self-management is becoming more important. Currently, there are self-monitoring applications that facilitate self-management, but it is still unclear which factors, on the level healthcare consumers, influence use and whether the trend in use of self-monitoring applications over the time differs in subgroups of healthcare consumers.

Methods: Data from 3,921 Dutch healthcare consumers was used for this cross-sectional study. Secondary analyses of existing data where performed. The relationship between patient- and disease-specific factors and use/willingness to use self-monitoring applications for self-management was assed. Univariate logistic regression analyses where preformed to select potential predictors for the multivariate logistic regression analyses. Trend analyses where preformed to asses change in use/willingness to use over time.

Results: lower age, higher level of education and higher income are positively related to using a technological device to track physical activity (SMA-1) and willingness to measure and maintain health values using the internet or with an application (SMA-2). In addition to that, willingness to use a device that regularly measures health values and sends them to a healthcare provider (SMA-3) is also associated with males, presence of a chronic condition, ethnicity, occupation and working in the healthcare sector. SMA-1 and SMA-3 showed a positive trend in use/ willingness to use over time. For SMA-2 willingness tot use stays more or less the same.

Conclusion: This study provides the first evidence for factors, on the level healthcare consumers, that are related to use/willingness to use self-monitoring application. Lower educated people need more counselling in order to preform optimal self-monitoring behavior. The percentage use/willingness to use SMA-1 and SMA-3 has increased over time while the gap in use/willingness to use between higher and lower educated healthcare consumers remains similar.

Clinical Relevance : This study contributes to the implementation of self-monitoring applications in the Dutch healthcare system by tailoring to specific groups of healthcare consumers.

Keywords: self-management; self-monitoring; health behavior; eHealth.

INTRODUCTION

In recent years, there has been a growing demand for the reorganization of healthcare from secondary to primary care in the Netherlands(1,2). The increasing demand for change is triggered by 3 key aspects: 1- The ageing population, resulting in more healthcare consumers whit a chronic condition and an increasing demand for healthcare services. In addition, not only the number of healthcare consumers with a chronic condition is rising, treatment of healthcare consumers with chronic conditions becomes more complex because they often have more than one chronic condition (2,3). Contributing to this, 2- the growing shortage of healthcare professionals in the Netherlands is making the previous aspect an even bigger problem (2,3). At last, 3- both current and future health care costs are believed to be unsustainable (2). According to National Institute for Public Health and the Environment (RIVM) healthcare expenses are expected to increase by 2,9 percent each year. This means care expenditure will increase from 85.8 billion in 2015 to 174 billion euro in 2040 (3).

The demand for a shift from secondary to primary care asks for a different approach. Self-management can facilitate this. Bringing health care services closer to the patients enables them to self-manage their healthcare needs in collaboration with local primary care providers or informal care. Primary care professionals consider self-management as an essential component of chronic care (4). In addition, self-management can lead to a reduction in the use of health care services (5,6). The self-management approach is also in line with the current debate on the definition of health. A proposal for change has been made where the authors state that health should be formulated as the ability to adjust and self-manage in terms of social, physical and emotional challenges (7).

Self-management requires considerable effort from healthcare consumers and an active role in everyday decisions managing their health (8). In return, however, preforming self-management improves health outcomes, quality of life and reduces mortality and disability (9). Where healthcare consumers need to take an active role, for primary healthcare providers the self-management approach requires a more coaching role. The physiotherapist could play an important role in this as he or she treats many chronically ill patients, sees the patients more frequently and for longer periods of time each visit compared to other healthcare providers (10,11).

A key aspect of self-management is awareness of health (8). This applies to both the patient

and the healthcare provider. The healthcare provider must know what the patient is doing and what the patient wants to achieve in order to contribute to patients self-management and carry out the coaching role properly (12–14). Technology can facilitate this e.g. by self-monitoring applications and internet communication. Self-monitoring improves patient awareness of specific health values which can be a trigger to take action or consult a healthcare provider (9).

Despite the wide range of self-monitoring applications that is available, self-monitoring is not yet integrated in standard healthcare procedures (15,16). Previous research reported the lack of additional benefits, regular care being sufficient, technological difficulties and the association with a high degree of dependency as arguments for non-use (17). In addition, self-management tasks are partly disease specific and partly generic (18). Up until now it is still unknown which kind of healthcare consumers (in terms of characteristics) are using or willing to use self-monitoring applications for self-management. Recent literature examined the use of eHealth in general and indicated age, gender, socioeconomic status, long-term health problems, education and income as predictors for use (19,20). Previous studies on self-monitoring usage, only examined patient specific populations (4,16,21–23). These studies indicate that disease-specific factors can play an important role in willingness to self-monitor (4,16,21–23). For example, to which extend is the patient able to have influence by self-monitoring (diabetes vs. cancer) and what is the patient's believe about his or her capabilities to manage and control the disease (self-efficacy).

Considering the implementation of self-monitoring in standard healthcare, it is important to tailor this process to specific groups and settings (24). An important first step is to find out which healthcare consumer-specific factors are related to use and non-use, and what trend these factors show in relation to use over time. This leads to the following objectives (a) which factors, on the level of the healthcare consumers, are related to using different types of self-monitoring applications for self-management and (b) which subgroups can be distinguished that show a different trend in the use of self-monitoring tools for self-management compared to the average population?

METHODS

Recruitment

Data gathered for the eHealth-monitor 2013 up to 2018 (25–29) was used to perform secondary analysis for this cross-sectional study. The eHealth-monitor is an annual survey from Nivel and Nictiz that monitors the availability and use of eHealth applications by healthcare consumers and caregivers. This data was obtained from Nivels' (the Netherlands Institute for Health Services Research) Dutch Health Care Consumer Panel (COPA) (30). Each year a sample that is representative for the Dutch adult (18+) population was drawn from the COPA. The COPA consists of approximately 12.000 members who represent the Dutch population. The COPA is a so-called access panel where the members have agreed to answer questions on a regular base. Inclusion in the COPA is only possible by invitation. Inclusion criteria are: at least 18 years of age and a citizen of the Netherlands. The panel is regularly refreshed. To avoid the learning effect, members are deregistered after 4-5 years. COPA members are sent a questionnaire 2 to 3 times a year about experiences with or opinions about healthcare. COPA members indicate whether they want to receive a postal or digital questionnaire. Non-respondents receive two reminders. There were no additional inclusion criteria for participation in the eHealth-monitor questionnaire regarding the use of Self-monitoring applications.

Measurements

Participant Characteristics

The background characteristics had already been gathered using a questionnaire when they entered the COPA. The following healthcare consumer-related factors where used for this study: gender (0=female, 1=male), age, ethnicity (1=native, 2=western immigrant, 3= non-western immigrant), level of education (1=low, 2=medium, 3=high), income (1=low <€1450, 2=medium €1450-€2500, 3=high >€2500), occupation (1=student, 2=paid work, 3=unemployed, 4=incapacitated for work, 5=housewife/man, 6=retired, 7=other), self-reported general health (1=excellent, 2=very good, 3=good, 4=mediocre, 5=poor), self-reported mental health (1=excellent, 2=very good, 3=good, 4=mediocre, 5=poor), presence of a chronic condition (amount and type) and Profession (1=I am not, and never have been working as a healthcare provider, 2=I currently am working as a healthcare provider, 3=I have been working as a healthcare provider).

Measurement of self-monitoring applications usage

Participants were asked the following three questions regarding the use of self-monitoring applications: In the past 12 months I have; 1- used a technological device to track my physical activity (self-monitoring application 1, SMA-1), 2- measured and maintained health values using the internet or with an application (self-monitoring application 2, SMA-2) and 3- used a device that regularly measures health values and sends them to a healthcare provider (self-monitoring application 3, SMA-3). Participants could give the following answers: In the past 12 months I have; 1-used once, 2- used more than once, 3-not used and I don't want to use, 4-not used and I don't know if I want to use and 5-not used but would like to use. For SMA-1 and SMA-2 data from 2014 until 2018 was available for this study. For SMA-3 there was also data from 2013 available.

Statistical analyses

Defining use

Considering the number of cases per event, use of the Self-monitoring applications 1 to 3 (SMA-1 to 3) was categorized in two ways. 1: willingness to use defined as: used once, used more than once and not used but would like to use. For this categorization SMA-1 was labelled as SMA-1a. The use of SMA-1 was also defined as: used once or used more than once and labelled as SMA-1b. In this way a comparison of actual use and willingness to use can be made. Table 1 shows the definition of "use" for each SMA.

Self-monitoring applications	Users	Non-users	eHealth-monitor data used
SMA-1a	used once or used more than once	not used and I don't want to use, not used and I don't know if I want to use and not used but would like to use.	2014 to 2018
SMA-1b	used once, used more than once and not used but would like to use.	not used and I don't want to use, not used and I don't know if I want to use	2014 to 2018
SMA-2	used once, used more than once and not used but would like to use.	not used and I don't want to use, not used and I don't know if I want to use	2014 to 2018
SMA-3	used once, used more than once and not used but would like to use.	not used and I don't want to use, not used and I don't know if I want to use	2013 to 2018

Table 1. Categorization of SMA use

Chronic condition categorization

At the start of their COPA membership, participants were asked the following question in relation to chronic conditions: Can you mark below the conditions you have had in the past 12 months? Participants also had the opportunity to mark that they have another chronic condition or that they have no chronic condition. The variable "chronic condition" was analyzed in 2 ways: (1) chronic condition (0= no chronic condition, 1= one or more chronic conditions) and (2) the presence of (0=not present, 1=present) chronic conditions that can be controlled by self-managing (osteoarthritis, ischemic heart disease/heart failure, chronic backpain, COPD, asthma, hypertension, diabetes). This selection was based on previous research (16,31–33) and supported by the clinical expertise of the researchers and physiotherapeutic relevance.

Trend analyses

To give insight in subgroups that show a different trend in the use/willingness to use self-monitoring tools for self-management compared to the average population, the percentage of use/willingness to use each SMA is graphically displayed as a function of year. Factors that did not differ from the average population were removed from the graph in order to be able to display the data more clearly.

Statistics

Statistical analyses were preformed using STATA version 15.0. The Shapiro-Wilk test, histograms and Q-Q-plots are used to check on normality. A boxplot was used to graphically inspect data on outliers. In case of outliers the data was manually checked and noted as missing if they were unrealistic. Descriptive statistics were conducted to study patient characteristics and the distribution of use for each SMA. Results were presented by mean and standard deviation for continues variables and number and percentages for categorical variables.

Data was checked on multicollinearity by correlation coefficients and variance of influence (VIFs). Correlation coefficients above .8 and VIF values above 10 where considered as a cut of point to be included in the regression analysis (34).

Univariate logistic regression analysis were conducted to identify which characteristics are related to use of Self-monitoring applications. Dependent value: self-monitoring application 1-3 (SMA-1b: 1= used once + used more than once, 0= not used and I don't want to use + not used and I don't know if I want to use + not used but would like to use. SMA-1a+2+3: 1= used once + used more than once + not used but would like to use, 0= not used and I don't want

to use + not used and I don't know if I want to use). Independent values: participant characteristics (see Participant Characteristics). Independent values: participant characteristics (see section Participant Characteristics). Independent values that had an association with the use/willingness to use Self-monitoring applications were selected ($p<0.20$) for building the multivariate model considering that the used parameters may not be more than 10% of the minimum number of people with and without the event (35). A less strict p-value ($p<0.20$) was used to ensure the possible mutual influence of covariates is also taken into account. Assumptions for logistic regression were checked. Ultimately, multivariate logistic regression analyses were preformed using a backward stepwise method.

Sample size calculation is done by the rule of thumb that for each predictor variable a minimum of 10 outcome events should be used (35,36). This study contains 11 predictor variables with a total of 35 parameters which leads to a minimum sample of n=350 for each event.

Results

Respondents selection and sample characteristics

A total of 3.921 cases with a mean age of 55 years (sd: 16.429, range: 18-94) were used for secondary analyses of existing data (25–29). As shown in figure 1. a random sample from the COPA was drawn each year. A total of 2219 individual respondents took part in this study. the minimum sample of 350 per event was met. Table 2. shows the characteristics of the study sample.

Figure 1. Data that was used for this study

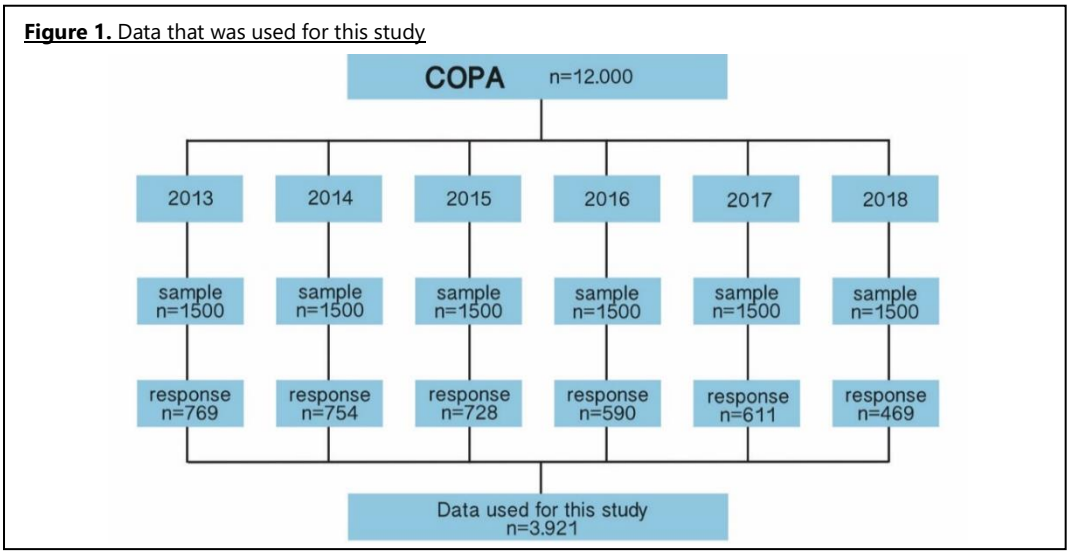


Table 2. Characteristics of the study sample

Characteristics	2013 (n=796) mean(sd) or n(%)	2014 (n=754) mean(sd) or n(%)	2015 (n=728) mean(sd) or n(%)	2016 (n=590) mean(sd) or n(%)	2017 (n=611) mean(sd) or n(%)	2018 (n=496) mean(sd) or n(%)	Study sample (n=) mean(sd) or n(%)
Age in years	53.4 (15.6)	52.5 (16.8)	55.3 (15.3)	56.7 (16.3)	54.7 (17)	59.8 (17.1)	55 (16.4)
Gender, male	359 (46.68%)	385 (51.06%)	394 (54.12%)	307 (52.03%)	317 (51.88%)	209 (44.56%)	1971 (50.27%)
Ethnicity							
Native	695 (90,49%)	670 (89.54%)	660 (90.66%)	547 (92.71%)	531 (88.35%)	423 (90.58%)	3.526 (90.34%)
Western immigrant	47 (6.12%)	34 (4,54%)	34 (4.67%)	23 (3.90%)	48 (7.99%)	23 (4.93%)	209 (5.35%)
Non-western immigrant	26 (3.39%)	45 (6.01%)	34 (4.67%)	20 (3.39%)	22 (3.66%)	21 (4.5%)	168 (4.3%)
Level of education							
High	218 (29.14%)	208 (28.11%)	191 (26.71%)	147 (25.39%)	165 (27.27%)	118 (26.05%)	1047 (27.27%)
Medium	427 (57.09%)	421 (56.89%)	394 (55.10%)	323 (55.79%)	357 (59.01%)	263 (58.06%)	2185 (56.90%)
Low	103 (13.77%)	111 (15%)	130 (18.18%)	109 (18.83%)	83 (13.72%)	72 (15.89%)	608 (15.83%)
Occupation							
Paid work	413 (54.27%)	412 (55.15%)	369 (51.25%)	307 (52.75%)	298 (50.17%)	206 (44.78%)	2005 (51.89%)
Unemployed	26 (3.42%)	30 (4.02%)	33 (4.58%)	23 (3.95%)	28 (4.71%)	15 (3.26%)	155 (4.01%)
Incapacitated for work	36 (4.73%)	43 (5.76%)	62 (8.61%)	35 (6.01%)	35 (5.86%)	23 (5.00%)	234 (6.06%)
Housewife/man	48 (6.31%)	31 (4.15%)	34 (4.72%)	25 (4.30%)	23 (3.87%)	21 (4.57%)	182 (4.71%)
Student	26 (3.24%)	35 (4.69%)	20 (2.78%)	15 (2.58%)	20 (3.37%)	14 (3.04%)	130 (3.36%)
Retired	197 (25.89%)	175 (23.43%)	183 (25.42%)	162 (27.84%)	163 (27.44%)	172 (37.39%)	1052 (22.23%)
Other	15 (1.97%)	21 (2.81%)	19 (2.64%)	15 (2.58)	27 (4.55%)	9 (1.96%)	106 (2.74%)
Income							
High	298 (39.73%)	263 (35.64%)	186 (31.79%)	184 (34.98%)	164 (38.05%)	112 (29.24%)	1207 (35.36%)
Medium	313 (41.73%)	301 (40.79%)	290 (49.57%)	233 (44.30%)	214 (49.65%)	195 (50.91%)	1546 (45.30%)
Low	139 (18.53%)	174 (23.58%)	109 (18.63%)	109 (20.72%)	53 (12.30%)	76 (19.84%)	660 (19.34%)
Physical health							
Excellent	54 (7.09%)	64 (8.57%)	54 (7.47%)	45 (7.65%)	60 (10.19%)	31 (6.75%)	308 (7.96%)
Very good	182 (23.88%)	218 (29.18%)	158 (21.85%)	134 (22.79%)	123 (20.88%)	98 (21.35%)	913 (23.60%)
Good	424 (55.64%)	359 (48.06%)	365 (50.48%)	304 (51.70%)	290 (49.24%)	242 (52.72%)	1984 (51.29%)
Mediocre	93 (12.20%)	92 (12.32%)	127 (17.57%)	89 (15.14%)	108 (18.34%)	79 (17.21%)	588 (15.20%)
Poor	9 (1.18%)	14 (1.87%)	19 (2.63%)	16 (2.72%)	8 (1.36%)	9 (1.96%)	75 (1.94%)
Mental health							
Excellent	145 (19.05%)	165 (22.12%)	146 (20.14%)	114 (19.39%)	142 (24.03%)	95 (20.52%)	807 (20.83%)
Very good	233 (30.62%)	240 (32.17%)	215 (29.66%)	177 (30.10%)	177 (29.95%)	139 (30.02%)	1181 (30.49%)
Good	336 (44.15%)	287 (38.47%)	309 (42.62%)	253 (43.03%)	235 (39.76%)	195 (42.12%)	1615 (41.69%)
Mediocre	44 (5.78%)	48 (6.43%)	45 (6.21%)	38 (6.46%)	31 (5.25%)	31 (6.70%)	237 (6.12%)
poor	3 (0.39%)	6 (0.80%)	10 (1.38%)	6 (1.02%)	6 (1.02%)	6 (1.02%)	34 (0.88%)
Working as a Healthcare provider							
I currently am	122 (16.05%)	108 (14.48%)	93 (13.01%)	71 (12.20%)	81 (13.59%)	69 (15.13%)	544 (14.11%)
I have been	122 (16.05%)	98 (13.14%)	105 (14.69%)	88 (15.12%)	83 (13.93%)	61 (13.38%)	557 (14.45%)
I'm not and never have	516 (67.89%)	540 (72.39%)	517 (72.31%)	423 (72.68%)	432 (72.48%)	326 (71.49%)	2754 (71.44%)
Chronic condition	299 (42.84%)	301 (41.52%)	363 (50.70%)	276 (47.67%)	265 (44.09%)	216 (47.16%)	1720 (45.54%)

Relationship of patient characteristics with use/willingness to use self-monitoring applications.

Univariate logistic regression analyses

In the univariate model for SMA1 (table 3), all variables - except self-reported mental health - turned out to be significant ($p < 0.2$) related to willingness to use SMA-1a. When actual use examined, all variables - except ethnicity turned out to be significant ($p < 0.2$) related to the use of SMA-1b. Notice that there are no major differences in the Odds Ratio's (OR) between the "*Use group*" and "*Willing to use group*". For the willingness to use SMA-2 (table 4), age ethnicity occupation, income, self-reported physical health and working as a healthcare provider turned

out to be significant (p <0.2). The disease related variables (chronic condition, and controllable chronic conditions) and gender turned out to be not significant (*p>0.2)*. The relationship with willingness to use SMA-3 (table 4) is significant for age, gender, ethnicity, level of education, occupation, income, physical health, working as a healthcare provider and the presence of a chronic condition. "Controllable chronic condition" turned out to be not significant.

Table 3. Univariate logistic regression analysis with the dependent variable: use/willingness to use SMA-1

Independent variable	SMA-1.a (n=2824)		SMA-1.b (n=2824)	
	OR (95% CI)	*p*	*OR (95% CI)*	*p*
Age in years	0.829 (0.710-0.969)	0.018	0.959 (0.953-0.965)	0.000
Gender (male)	1.206 (1.032-1.409)	0.018	0.856 (0.709-1.036)	0.109
Ethnicity				
Native (=ref)	-	-	-	-
Western immigrant	0.711 (0.488-1.037)	0.076	0.792 (0.468-1.262)	0.327
Non-western immigrant	1.152 (0.798-1.664)	0.451	1.122 (0.721-1.746)	0.610
Level of education				
High	3.161 (2.401-4.162)	0.000	4.402 (2.997-6.468)	0.000
Medium	1.812 (1.401-2.344)	0.000	2.300 (1.582-3.344)	0.000
Low (=ref)	-	-	-	-
Occupation				
Paid work	0.572 (0.373-0.876)	0.010	0.449 (0.292-0.692)	0.000
Unemployed	0.418 (0.238-0.736)	0.002	0.264 (0.139-0.502)	0.000
Incapacitated for work	0.279 (0.164-0.475)	0.000	0.206 (0.114-0.375)	0.000
Housewife/man	0.258 (0.143-0.468)	0.000	0.189 (0.094-0.378)	0.000
Student (=ref)	-	-	-	-
Retired	0.185 (0.117-0.291)	0.000	0.086 (0.051-0.143)	0.000
Other	0.471 (0.259-0.856)	0.013	0.190 (0.089-0.406)	0.000
Income (high)				
High	1.133 (0.889-1.442)	0.312	1.165 (0.846-1.604)	0.349
Medium	1.781 (1.391-2.280)	0.000	2.145 (1.564-2.942)	0.000
Low (=ref)	-	-	-	-
Physical health (low)	0.746 (0.682-0.817)	0.000	0.700 (0.627-0.781)	0.000
Mental health (low)	0.963 (0.885-1.049)	0.389	0.923 (0.834-1.023)	0.127
Working as a Healthcare provider				
I currently am	1.902 (1.529-2.366)	0.000	1.835 (1.434-2.347)	0.000
I have been	0.983 (0.779-1.241)	0.886	0.714 (0.521-0.977)	0.035
Am not and never have (=ref)	-	-	-	-
Chronic condition	0.803 (0.674-0.957)	0.014	0.760 (0.617-0.936)	0.010
Controllable chronic condition	0.617 (0.527-0.724)	0.000	0.543 (0.445-0.663)	0.000

Table 4. Univariate logistic regression analysis with the dependent variable: willingness to use of SMA-2 & 3

Independent variable	SMA-2 (n=2827)		SMA-3 (n=3532)	
	OR (95% CI)	*p*	*OR (95% CI)*	*p*
Age in years	0.983 (0.979-0.988)	0.000	0.992 (0.987-0.996)	0.001
Gender (male)	1.013 (0.866-1.186)	0.869	1.140 (0.981-1.326)	0.087
Ethnicity				
Native (=ref)	-	-	-	-
Western immigrant	0.684 (0.465-1.001)	0.054	0.855 (0.601-1.218)	0.387
Non-western immigrant	1.512 (1.057-2.178)	0.024	1.533 (1.088-2.159)	0.014
Level of education				
High	2.409 (1.834-3.164)	0.000	1.995 (1.534-2.596)	0.000
Medium	1.712 (1.328-2.207)	0.000	1.546 (1.208-1.978)	0.001
Low (=ref)	-	-	-	-
Occupation				
Paid work	0.946 (0.613-1.460)	0.802	0.982 (0.650-1.486)	0.930
Unemployed	0.857 (0.485-1.514)	0.595	1.133 (0.665-1.930)	0.647
Incapacitated for work	0.704 (0.415-1.193)	0.192	0.654 (0.390-1.100)	0.107
Housewife/man	0.473 (0.257-0.874)	0.017	0.610 (0.348-1.069)	0.084
Student	-	-	-	-
Retired	0.568 (0.361-0.892)	0.014	0.664 (0.432-1.021)	0.062
Other	1.076 (0.591-1.959)	0.812	0.936 (0.519-1.691)	0.827
Income				
High	1.636 (1.274-2.101)	0.000	1.511 (1.194-1.912)	0.001
Medium	1.191 (0.933-1.520)	0.161	1.128 (0.894-1.423)	0.311
Low (=ref)	-	-	-	-
Physical health	0.927 (0.847-1.014)	0.098	0.917 (0.840-1.001)	0.053
Mental health	1034 (0.950-1.127)	0.439	1.008 (0.928-1.095)	0.854
Working as a Healthcare provider				
I currently am	1.530 (1.226-1.909)	0.000	1.579 (1.287-1.937)	0.000
I have been	1.010 (0.799-1.276)	0.933	0.914 (0.729-1.146)	0.435
Am not and never have (=ref)	-	-	-	-
Chronic condition	1.086 (0.907-1.300)	0.372	1.132 (0.956-1.341)	0.151
Controllable chronic condition	1.023 (0.874-1.198)	0.776	1.069 (0.919-1.243)	0.389

Backward stepwise multivariate logistic regression analyses

In the multivariate model (table 5 and 6), age, high and medium income, high and medium level of education and working as a healthcare provider are related to willingness to use a technological device to track physical activity (SMA-1a). For the use only group (SMA-1b) Age, high and medium level of education, high income and occupation retired and "other" were included in the model. Age, high and medium level of education, ethnicity (western immigrant) and high income are related to willingness to measure and maintain health values using the internet or with an application (SMA-2). Working as a healthcare provider, males, presence of a chronic condition, medium and high level of education, ethnicity, occupation retired and high income are related to willingness to use a device that regularly measures health values and sends them to a healthcare provider (SMA-3).

Table 5. Backward-stepwise Multivariate logistic regression analysis with the dependent variable: use of SMA-1

Independent variable	SMA-1a (n=2824)		Independent variable	SMA-1b (n=2824)	
	OR (95% CI)	*p*		*OR (95% CI)*	*p*
Medium income	1.270 (0.980-1.646)	0.071	Occupation "retired"	0.654 (0.424-1.010)	0.055
Age	0.972 (0.966-0.977)	0.000	Age	0.960 (0.960-0.978)	0.000
High education	1.839 (1.317-2.568)	0.000	High income	1.465 (1.161-1.849)	0.001
High income	1.522 (1.162-1.994)	0.002	Occupation "other"	0.521 (0.245-1.110)	0.091
Working as hcp[1]	1.394 (1.085-1.790)	0.009	Medium education	1.841 (1.182-2.867)	0.007
Medium education	1.389 (1.032-1.869)	0.030	High education	2.493 (1.556-3.994)	0.000

[1]hcp: Healthcare provider

Table 6. Backward-stepwise Multivariate logistic regression analysis with the dependent variable: use of SMA-2 & SMA-3

Independent variable	SMA-2 (n=2824)		Independent variable	SMA-3 (n=2824)	
	OR (95% CI)	*p*		*OR (95% CI)*	*p*
Age	0.988 (0.983-0.994)	0.000	Working as hcp[1]	1.530 (1.209-1.936)	0.000
High income	1.219 (1.007-1.475)	0.042	Gender (male)	1.275 (1.072-1.515)	0.006
Ethnicity 2[2]	0.678 (0.430-1.069)	0.094	Chronic condition	1.325 (1.092-1.606)	0.004
High education	1.806 (1.311-1.821)	0.000	Ethnicity 3[2]	1.492 (1.017-2.188)	0.041
Medium education	1.410 (1.063-1.871)	0.017	Medium education	1.466 (1.113-1.932)	0.007
			High education	1.720 (1.263-2.343)	0.001
			High income	1.174 (0.980-1.406)	0.081
			Occupation "retired"	0.809 (0.658-0.995)	0.044

[1]hcp= Healthcare provider. [2] 2= western immigrant 3=non-western immigrant.

Trend analysis

The percentage of use/willingness to use of the self-monitoring applications were calculated as a function of time for the independent variables. A trendline of the average population is drawn as a comparison. Variables that showed a different trend in the use of self-monitoring tools for self-management compared to the average population were selected (figure 2-4). For SMA-1 the variables were: paid work, student, retired, No chronic Condition, excellent health, poor health and lower educated. For SMA-2 the variables were: poor health, high education, and lower education. For SMA-3 the variables were: poor health, high income, low income, lower education and high education. Trend analysis for SMA-1 indicate an increasing use of technological devices to track physical activity. For SMA-2 the percentage that was willing to measure and maintain health values using the internet or with an application stayed more or less the same. The percentage of healthcare consumers that is willing to use a device that regularly measures health values and sends them to a healthcare provider (SMA-3) also increases over the years, but there tends to be les variance between the groups.

Figure 2. trend analyses for SMA-1

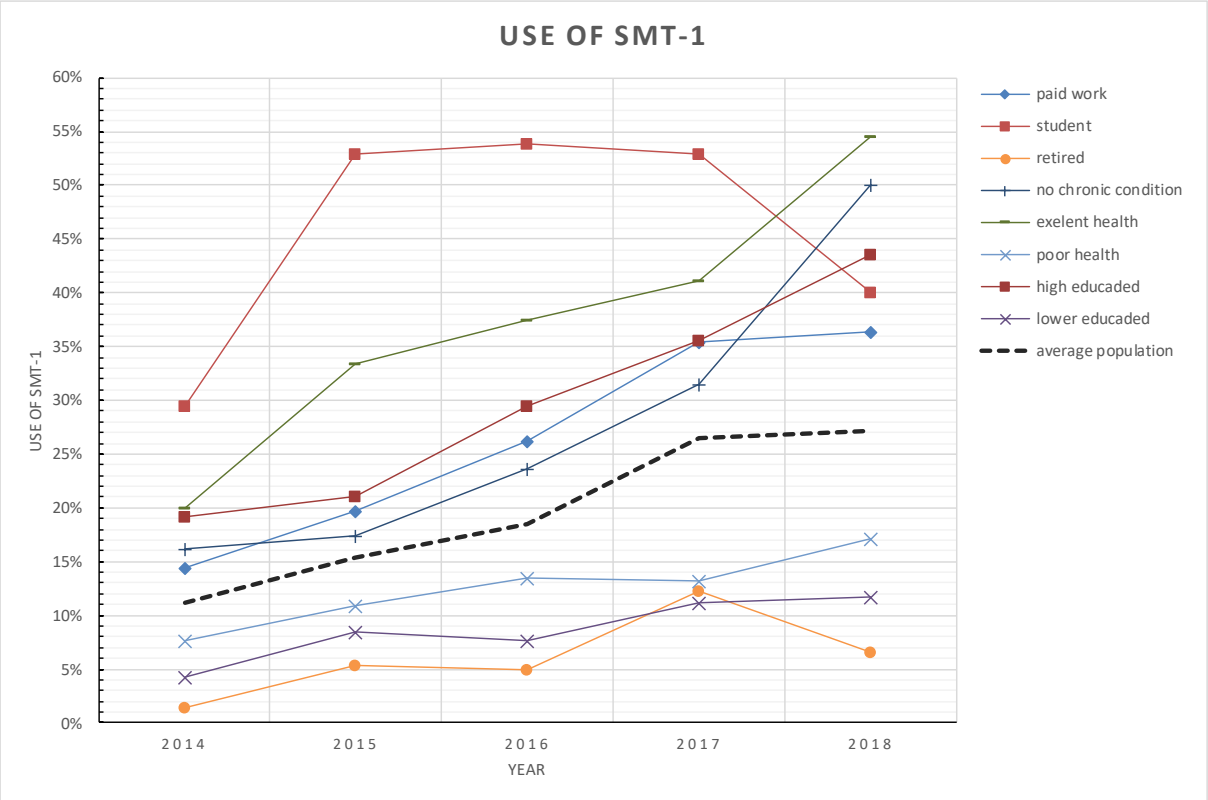


Figure 3. trend analyses for SMA-2

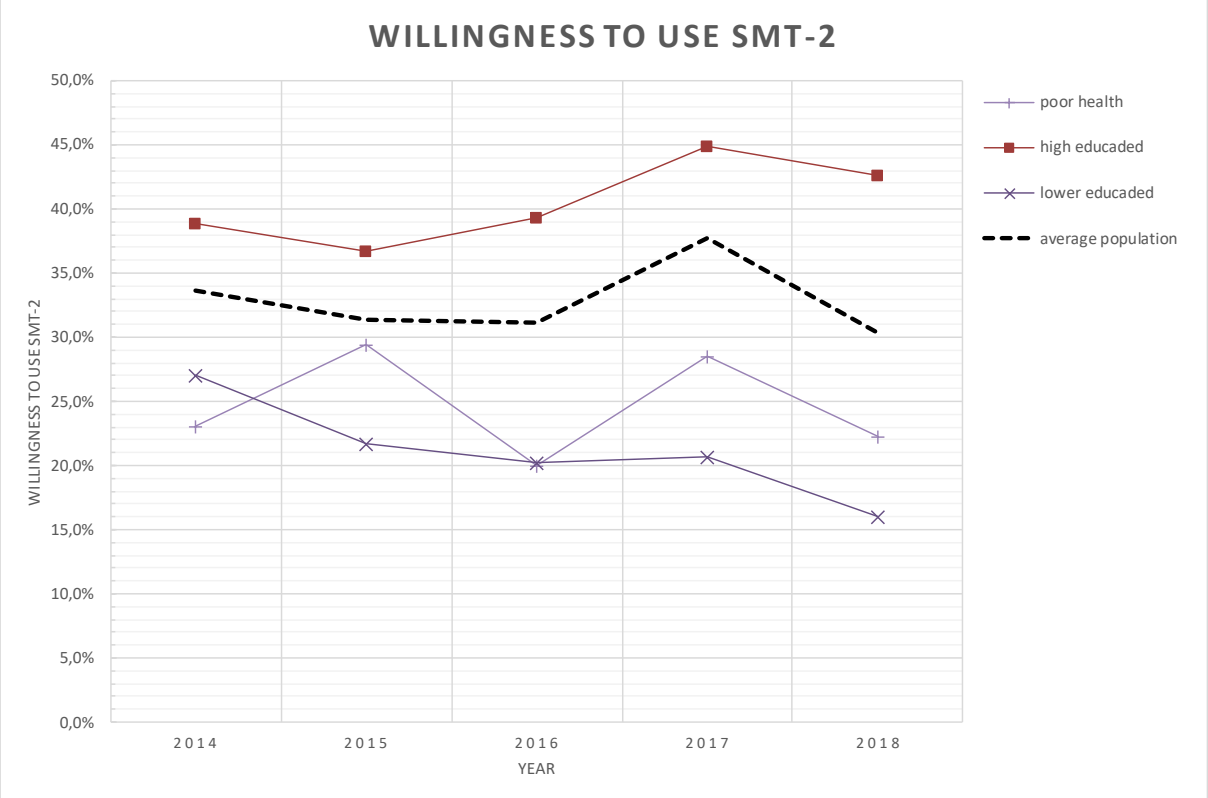
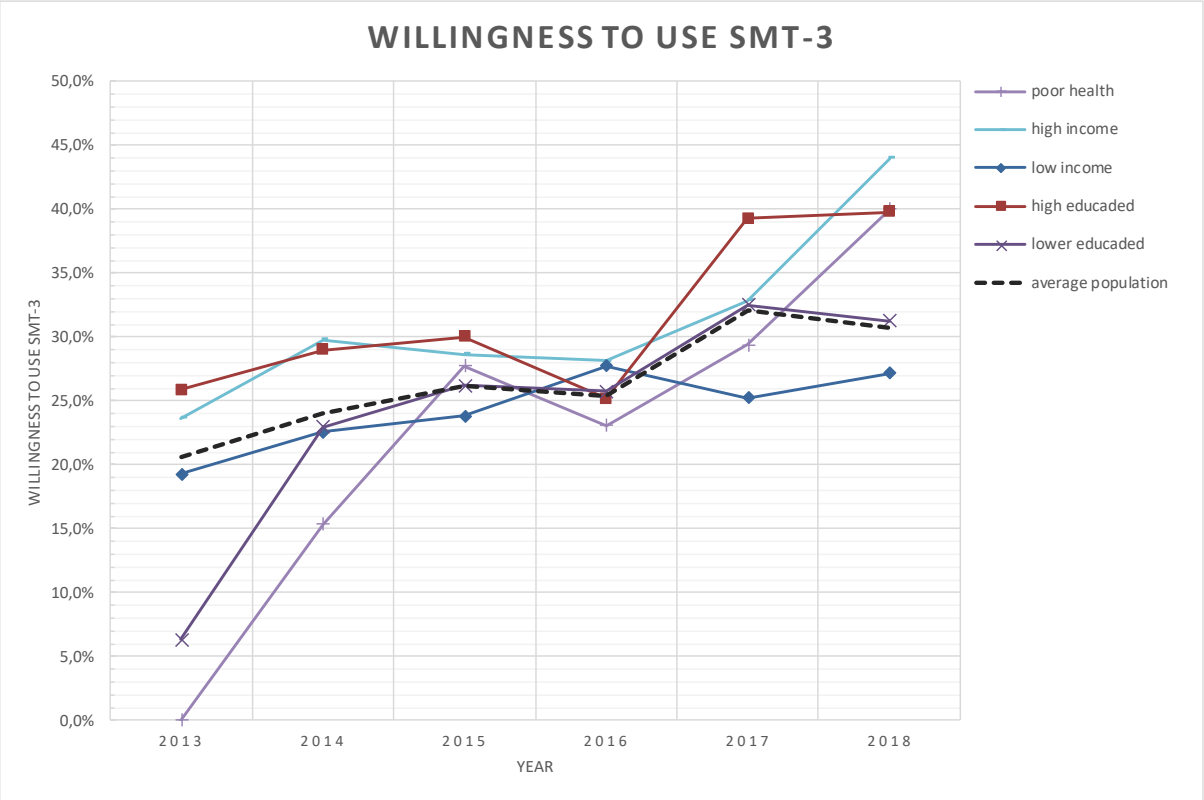


Figure 4. trend analyses for SMA-3



DISCUSSION

Principal results

This study provides the first evidence of a relationship between Dutch healthcare consumer-specific factors and use/willingness to use self-monitoring applications for self-management. Healthcare consumers that are higher educated and have a higher income are positively (OR ranging from 1.174 to 2.493) related to use/willingness to use the self-monitoring applications in this study. No relation was found for lower educated consumers and lower income, while this group has a greater risk of developing chronic conditions (37–40) In addition, despite potential improvement on health outcomes and quality of life that self-monitoring can provide for this group (9), "chronic condition controllability" is not related to use/willingness to use self-monitoring applications. Previous research indicates that patients indicate a lack of potential additional benefits, and regular care being sufficient as reason for non-use (17) . Given the potential health benefits in these groups, implementation should be tailored to these groups and focus on highlighting the additional benefits of self-monitoring.

Where trend analyses for SMA-1 (using a technological device to track physical activity and SMA-3 (willingness to use use a device that regularly measures health values and sends them to a healthcare provider) illustrate growth in use/willingness to use over time, SMA-2

(willingness to measure and maintain health values using the internet or with an application) stays more or less the same over time. and explanation for this can be found in the fact that measuring and maintain health values demands substantial effort, were patients experience many barriers in active self-management (41). In contrast to SMA-3, where the healthcare consumer has support from a healthcare professional and for SMA-1, it's all about measuring not maintaining. Trend analyses also illustrate the gap between higher and lower educated healthcare consumers. It is remarkable that, over time, the distance between the lines of the groups remains similar for SMA-1 and SMA-2. The gap between the lines in SMA-3 (figure 4.) is smaller. This can be explained by the fact that for SMA-3 also support from the healthcare system is needed and this is not yet integrated in standard healthcare.

Against our expectations, no evidence was found for a difference between analysis of actual users and willingness to use (SMA1a and SMA-1b). Table 5 shows a slight difference in the OR and significance of the factors. This is a positive finding when it comes to promoting self-monitoring in standard healthcare because this is the first indication that the group that is willing to use, might not differ from the group actual users. This group is likely to become users when self-monitoring becomes more and more intergraded in standard healthcare.

Integration of self-monitoring in standard healthcare also raises some questions. When self-monitoring is entering the healthcare system, the ethical discussion becomes highly relevant. Self-monitoring encroach with the personal life of healthcare consumers. Healthcare consumers are more responsible for their healthcare with the consequence of constantly monitoring these devises in the home environment where it can have serious consequences on self-identity (42). In addition, the affordability of self-monitoring devices should also be considered. Lower socio-economic groups should not be disadvantaged because they cannot afford such devices. (43) These arguments should not simply be discarded because there are good arguments for the implementation of self-monitoring in standard healthcare.

Due to the increasing demand for the reorganization of healthcare from secondary to primary care in the Netherlands, it is to be expected that there will be a shift in the demand for care. care users will have control of their own lives (self-management), with the associated need for coaching in the area of movement and lifestyle. The physiotherapist is competent for the supervision in the area of movement and lifestyle of these (risk) groups (10) and can use self-monitoring applications to gain insight into the need for care and .

Strengths and limitations

The strength of this study is its focus on healthcare consumers in general, where previous studies mainly focused on patients. The sample size (n=3,912) and the representation of the adult Dutch population provide generalizability. A limitation of this study is the use of exciting data. This limits the research in focusing on recent findings in the literature. Sometimes, questions do not fully answer the question that is necessary for the research questions and compromises had to be made. For example the monthly income of a household may give a biased picture of the variable income of an individual. Another limitation of this study is that patient characteristics are not yearly updated. It may be that a respondent is no longer a student, for example, but is now working, or that a respondent may meanwhile have a chronic disorder. If a respondent is included in several years, it may be that the patient characteristics are not correct. In order to prevent this from effecting the results, the number of respondents who were repeatedly included in the study was examined beforehand and the potential impact was considered to be acceptable.

CONCLUSION

This study provides the first evidence for factors, on the level healthcare consumers, that are related to use/willingness to use self-monitoring application. The "Lower educated" group and the "low income" group need more counselling in order to preform optimal self-monitoring behavior. The percentage use/willingness to use SMA-1 and SMA-3 has increased over time while the gap in use/willingness to use between higher and lower educated healthcare consumers remains. In order to facilitate the further implementation of self-monitoring in Dutch healthcare, focusing on the healthcare consumer alone is not enough. Facilitation from healthcare organizations and the government is necessary to give patients the possibility of applying self-monitoring for self-management, give insight into the potential benefits and to guide them where necessary.

REFERENCES

1. Kroneman M, Boerma W, van de Berg M, Groenewegen P, de Jong J, van Ginneken E. Netherlands: Health system review 2016. Nivel. 2016;18(2):1.

2. Taskforce. De Juiste Zorg Op De Juiste Plek. 2018.

3. RIVM. Volksgezondheid Toekomst Verkenning 2018: Een gezond vooruitzicht Synthese. 2018;

4. Huygens MWJ, Vermeulen J, Swinkels ICS, Friele RD, Van Schayck OCP, De Witte LP. Expectations and needs of patients with a chronic disease toward self-management and eHealth for self-management purposes. BMC Health Serv Res. 2016;16(1):1–11.

5. Panagioti M, Richardson G, Small N, Murray E, Rogers A, Kennedy A, et al. Self-management support interventions to reduce health care utilisation without compromising outcomes: a systematic review and meta-analysis. BMC Health Serv Res. 2014;14:356.

6. McBain H, Shipley M, Newman S. The impact of self-monitoring in chronic illness on healthcare utilisation: A systematic review of reviews. BMC Health Serv Res. 2015;15(1):1–10.

7. Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, et al. How should we define health? BMJ. 2011 Jul 26;343:d4163.

8. Barlow J, Wright C, Sheasby J, Turner A, Hainsworth J. Self-management approaches for people with chronic conditions: A review. Patient Educ Couns. 2002;48(2):177–87.

9. Richard AA, Shea K. Delineation of Self-Care and Associated Concepts. J Nurs Scholarsh. 2011;43(3):255–64.

10. De Vries C, Hagenaars L, Kiers H, Schmitt M. Beroepsprofiel Fysiotherapeut. K Ned Genoot voor Fysiother. 2014;32.

11. Margretha Buining E, Kooijman MK, Swinkels ICS, Pisters MF, Veenhof C. Exploring physiotherapists' personality traits that may influence treatment outcome in patients with chronic diseases: a cohort study. 2015;

12. Lorig KR, Sobel DS, Stewart AL, Brown BW, Bandura A, Ritter P, et al. Evidence Suggesting That a Chronic Disease Self-Management Program Can Improve Health Status While Reducing Hospitalization: A Randomized Trial. Vol. 37, Care. 1999.

13. Brady TJ, Murphy L, O'colmain BJ, Beauchesne D, Daniels B, Greenberg M, et al. A Meta-Analysis of Health Status, Health Behaviors, and Health Care Utilization Outcomes of the Chronic Disease Self-Management Program. Prev Chronic Dis. 2013;10:120112.

14. Kivelä K, Elo S, Kyngä H, Kä M. The effects of health coaching on adult patients with chronic diseases: A systematic review. Patient Educ Couns. 2014;97:147–57.

15. Ross J, Stevenson F, Lau R, Murray E. Factors that influence the implementation of e-health: A systematic review of systematic reviews (an update). Implement Sci. 2016;11(1):1–12.

16. Huygens MWJ, Swinkels ICS, de Jong JD, Heijmans MJWM, Friele RD, van Schayck OCP, et al. Self-monitoring of health data by patients with a chronic disease: does disease controllability matter? BMC Fam Pract. 2017;18(1):40.

17. Sanders C, Hendy J, Chrysanthaki T, Bardsley M, Newman SP, Rogers A, et al. Exploring barriers to participation and adoption of telehealth and telecare within the Whole System Demonstrator trial: A qualitative study. BMC Health Serv Res. 2012;12(1):220.

18. van Houtum L, Rijken M, Heijmans M, Groenewegen P. Patient-Perceived Self-Management Tasks and Support Needs of People with Chronic Illness: Generic or Disease Specific? Ann Behav Med. 2015;49(2):221–9.

19. Kontos E, Blake KD, Chou WYS, Prestin A. Predictors of ehealth usage: Insights on the digital divide from the health information national trends survey 2012. J Med Internet Res. 2014;16(7):1–16.

20. Torrent-Sellens J, Díaz-Chao Á, Soler-Ramos I, Saigí-Rubió F. Modelling and predicting eHealth usage in Europe: A multidimensional approach from an online survey of 13,000 European Union Internet Users. J Med Internet Res. 2016;18(7).

21. Warsi A, Wang PS, LaValley MP, Avorn J, Solomon DH. Self-management Education Programs in Chronic Disease. Arch Intern Med. 2004;164(15):1641.

22. Mamykina L, Smaldone AM, Bakken SR. Adopting the Sensemaking Perspective for Chronic Disease Self-Management Graphical abstract HHS Public Access. J Biomed Inf. 2015;56(212):406–17.

23. Lorig KR, Holman HR, Med AB. Self-Management Education: History, Definition, Outcomes, and Mechanisms. Ann Behav Med. 2003;26(1):1–7.

24. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. Lancet. 2003;362(9391):1225–30.

25. Wouters M, Swinkels I, Sinnige J, Jong J de, Brabers A, Britt van Lettow, et al. eHealth monitor 2017; Kies bewust voor eHealth. Ehealth -Monitor 20. 2017.

26. Krijgsman J, Swinkels ICS, Britt van Lettow, Jong J de, Out K, Friele R, et al. Meer dan techniek. Ehealth -Monitor 2016. 2016.

27. Krijgsman J, Peeters J, Burghouts A, Brabers A, Jong J de, Moll T, et al. Tussen vonk en vlam. Ehealth -Monitor 2015. 2015.

28. Krijgsman J, Peeters J, Burghouts A, Brabers A, de Jong J, Beenkens F, et al. Op naar meerwaarde! Ehealth -Monitor 2014. 2014.

29. KKrijgsman J, Bie de J, Burghouts A, de Jong J, Cath G-J, van Gennip L, et al. eHealth, verder dan je denkt. Ehealth -Monitor 2013. 2013.

30. Brabers AEM, Reitsma-Van Rooijen M, De Jong JD. Consumentenpanel Gezondheidszorg Basisrapport met informatie over het panel (2015). 2015 [cited 2018 Nov 4]; Available from: http://www.nivel.nl

31. McCartney DE, McManus RJ. Self-monitoring and self-management: new interventions to improve blood pressure control. Curr Opin Nephrol Hypertens. 2016;25(6):502–7.

32. Heneghan CJ, Garcia-alamino JM, Spencer EA, Ward AM, Perera R, Bankhead C, et al. Self-monitoring and self-management of oral anticoagulation (Review) SUMMARY OF FINDINGS FOR THE MAIN COMPARISON. Cochrane Database Syst Rev. 2016;(7):CD003839.

33. Slevin P, Kessie T, Cullen J, Butler MW, Donnelly SC, Caulfield B. Exploring the potential benefits of digital health technology for the management of COPD: a qualitative study of patient perceptions. ERJ Open Res. 2019;5(2):00239–2018.

34. Myers R. Classical and Modern Regression with Applications (Duxbury Classic). Pacific Grove, CA: Duxbury Press; 1990.

35. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol. 1996;49(12):1373–9.

36. Vittinghoff E, McCulloch CE. Relaxing the Rule of Ten Events per Variable in Logistic and Cox Regression. Am J Epidemiol. 2007 Jan 12;165(6):710–8.

37. Majer IM, Nusselder WJ, Mackenbach JP, Kunst AE. Socioeconomic inequalities in life and health expectancies around official retirement age in 10 Western-European countries. J Epidemiol Community Health. 2011;65(11):972–9.

38. Schillinger D, Barton LR, Karter AJ, Wang F, Adler N. Does literacy mediate the relationship between education and health outcomes? A study of a low-income population with diabetes. Public Health Rep. 2006;121(3):245–54.

39. Sarkar U, Karter AJ, Liu JY, Adler NE, Nguyen R, López A, et al. Social disparities in internet patient portal use in diabetes: Evidence that the digital divide extends beyond access. J Am Med Informatics Assoc. 2011;18(3):318–21.

40. Masseria C, Giannoni M. Equity in access to health care in Italy: A disease-based approach. Eur J Public Health. 2010;20(5):504–10.

41. Jerant AF, Von Friederichs-Fitzwater MM, Moore M. Patients' perceived barriers to active self-management of chronic conditions. Patient Educ Couns. 2005;57(3):300–7.

42. Gilmartin C, Arbe-Barnes EH, Diamond M, Fretwell S, McGivern E, Vlazaki M, et al. Varsity medical ethics debate 2018: Constant health monitoring - the advance of technology into healthcare. Philos Ethics, Humanit Med. 2018;13(1):1–7.

43. Carter A, Liddle J, Hall W, Chenery H. Mobile Phones in Research and Treatment: Ethical Guidelines and Future Directions. JMIR mHealth uHealth. 2015;3(4):e95.