Differences in e-health access, use, and perceived benefit between different socio-economic groups in the Dutch context: a secondary cross-sectional study

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Abstract

Background: There is a growing concern that digital healthcare may exacerbate existing differences in health. Digital healthcare or e-health is defined as the digital applications that are used in healthcare. Differences in access to and perceived benefits of digital technology among socio-economic groups are commonly referred to as the digital divide. While research on differences in health outcomes between socio-economic groups in the context of e-health has focused mainly on single interventions, there is a need for greater understanding of population-wide disparities in e-health access, use, and perceived benefits.

Objective: The aim of this study is to investigate e-health access, usage, and perceived benefits across different socio-economic groups within the Dutch population.

Methods: A survey was conducted among 1,500 panel members of the Nivel Dutch Health Care Consumer Panel to assess their access to, use of, and perceived benefits of e-health. Results were stratified into nine socio-economic position (SEP) populations based on three indicators: education, standardized income, and socio-economic status level of the neighborhood. Logistic regression analyses were carried out to evaluate whether the outcomes varied significantly across different SEP groups. To control for confounding, age was included as a covariate.

Results: The response rate was 56.6% (849/1500). Subpopulations with low SEP have less access to and use of e-health than subpopulations with medium or high SEP. The difference in access (OR 5.72, 95% CI 3.06 - 10.72) and usage (OR 4.96, 95% CI 2.66 - 9.24) of e-health between low and highly educated respondents is most profound.

Conclusions: Conclusion: This study found that access and usage of e-health varied significantly among low, medium, and high SEP groups in the Dutch population, depending on the SEP indicators used. The results underline the importance of activities and policies aimed at improving e-health accessibility and usage among low SEP groups to reduce disparities in health between difference socio-economic groups.

Conclusion: This study found that access and usage of e-health varied significantly among low, medium, and high SEP groups in the Dutch population, depending on the SEP indicators used. The results underline the importance of activities and policies aimed at improving e-health accessibility and usage among low SEP groups to reduce disparities in health between difference socio-economic groups.

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Differences in e-health access, use, and perceived benefit between different socio-economic groups in the Dutch context: a secondary cross-sectional study

Abstract

Background: There is a growing concern that digital healthcare may exacerbate existing health disparities. Digital healthcare, or e-health encompasses the digital applications that are used in healthcare. Differences in access, use and perceived benefits of digital technology among socio-economic groups are commonly referred to as the digital divide. Current research shows that people in lower socio-economic positions use e-health less frequently.

Objective: This study aims to: 1) investigate the association between socio-economic position and e-health access to, use of and perceived benefit within the adult Dutch population, and 2) evaluate disparities in e-health access, use and perceived benefit through three socio-economic variables: education, standardized income and the socio-economic status of the neighborhood.

Methods: A secondary analysis was conducted on data from the Nivel Dutch Health Care Consumer Panel (response rate 57% (849/1500), to assess access to, use of, and perceived benefits from e-health. These data were collected to monitor e-health developments in the Netherlands. E-health was examined through two concepts: 1) e-health in general and 2) websites, apps and wearables. Results were stratified into nine socio-economic position (SEP) populations based on three indicators: education, standardized income, and socio-economic status level of the neighborhood. Logistic regression analyses were performed to evaluate whether the outcomes varied significantly across different SEP groups. Age was included as a covariate to control for confounding.

Results: This study confirms the association between e-health and socio-economic position and shows that low SEP respondents have less access (OR 5.72, 95% CI 3.06 - 10.72) and use (OR 4.96, 95% CI 2.66 - 9.24) of e-health compared to medium or high SEP respondents. Differences were most profound when stratifying for levels of education.

Conclusion: Access to and use of e-health has a socio-economic gradient and emphasize that SEP indicators cannot be used interchangeably to assess e-health access and use. The results underline the importance of activities and policies aimed at improving e-health accessibility and usage among low SEP groups to mitigate disparities in health between different socio-economic groups.

Keywords: e-health; socioeconomic factors; education; income; neighborhood; health disparities; cross-sectional studies

Introduction

Digital healthcare is expected to provide benefits for healthcare systems, providers, and patients and is considered a solution to address workforce shortages and rising healthcare costs [1-4]. Moreover, digital health care is anticipated to enhance the quality of care, stimulate patient self-management, and improve health accessibility and equity [1-4]. Digital healthcare, or e-health, is defined as the digital applications that are used in healthcare. Healthcare policies focus on an increased use of and dependency upon e-health application [4-6]. Concerns have been raised that the digital health care may not be equally accessible for all [7-13]. Populations with lower socio-economic positions (SEP) are more likely to encounter financial, skill, or cognitive barriers to accessing and using e-health, such as limited access to devices, limited digital health skills, or limited ability to take the initiative in using e-health [7, 11-16] Additionally, these populations

experience challenges in comprehending and implementing health information and healthy behaviors in daily life [17-21].

The demand for healthcare services is often higher in low SEP populations, as people with a low SEP suffer more often from (chronic) illnesses [18, 19, 22, 23] . Research shows that low SEP populations often have different views on health and on the possible benefit from healthy behaviors compared to high SEP populations [24-27]. Studies find that low SEP populations have less time, more stress and limited financial capacities to implement healthy behaviors [26]. Next to this, it is theorized that health beliefs often find origin in the health beliefs of previous generations [24-27] In the context of low SEP, the expectation of a shorter life and the belief that their own behavior has limited influence on their longevity, poses barriers to adhering to healthy behaviors [20]. Therefore, digitalization of healthcare could therefore seriously impact the access and utilization of healthcare for those who need it most [13, 5, 6, 28-31].

National digital connectivity and policies that stimulate the transition towards a digital healt care system could improve the implementation and accessibility of e-health. The European Union (EU) and EU member states deploy policies to realize the digital transition of healthcare systems [5, 6]. Some states, such as the Netherlands, have been experimenting with digital healthcare for over a decade [4, 6]. Most Dutch households (98%) have fast broadband coverage (2020) and 88% of the Dutch population uses mobile broadband (2019), which indicates use of a mobile phone or other device with mobile internet access [5]. The level of connectivity in the Netherlands could facilitate the implementation of digital healthcare [5].

Several countries have developed national e-health monitoring programs to monitor the uptake and effects of e-health among healthcare professionals and citizens [32, 33, 34]. From a citizen’s perspective, the monitoring programs focus on the use and the evaluation of e-health that involve citizen interaction [32, 33, 34]. This includes applications such as websites, apps and wearables that citizens can use independently or involve e-health tools that facilitate digital communication with a healthcare professional, such as videocalls or messaging via patient portals [32, 33, 34]. This article is based on secondary data-analysis of the Dutch e-health monitoring program (2021) [29], which collects data about access, use and perceived benefit from e-health among Dutch citizens through questionnaires.

There is still limited understanding of the relationship between SEP and e-health access, use and perceived benefit and that understanding is generally limited to either access, use or perceived benefit from e-health, specific e-health applications or specific subpopulations. Research showed the relation between SEP and the use of personal health records [35] and mobile apps [36]. Other research focuses on either the benefit from[37] or use of e-health [38, 39] or specific patient groups such as cancer survivors [40, 41], or citizens bound to specific locations [42]. To our knowledge, insight into differences in e-health access, use, and perceived benefits and how different indicators for SEP display these differences within the Dutch general population aged 18 and above is largely unknown. This study aims to assess differences in e-health related access, usage, and perceived benefits for different socio-economic populations, based on education, standardized income, and socio-economic status (SES) level of the neighborhood in the Netherlands. Findings of this study give insight into the disparities in access to, use of and perceived benefit from e-health in a highly connected country with an increasingly digitalized healthcare system. The results are insightful for other contexts that aim for or experience the same ambitions to transition to a digital healthcare system.

Methods

Panel

Data from the Dutch Health Care Consumer Panel (DHCCP) were used [43]. The DHCCP is a panel managed by Nivel

(the Netherlands Institute for Health Services Research) and currently (as of September 2023) consists of approximately 11,500 panel members aged eighteen years and older [43]. For this study, a study sample of 1.500 panel members was drawn by researchers from DHCCP. The study sample was representative of the Dutch population aged 18 and above regarding age and sex [43]. Background characteristics of panel members, including their sex, age, level of education, net monthly income per household and four-digit postal codes were known. The panel was periodically renewed to ensure representative samples of the adult population in the Netherlands can be drawn. New panel members were recruited by buying an address file from an address supplier [43]. As a result, possible new members were sampled at random from the general population in the Netherlands [43]. The panel could only be joined through invitation. It was not possible for people to sign up on their own initiative [43]. Upon membership, panel members were being informed of the purpose, scope, method and use of the panel [43]. Based on this information, participants could give permission to participate in the panel [43]. A written or digital informed consent was obtained at the time of registration of a new member to the panel [43]. Panel members were asked to participate approximately four or five times per year [43]. Participation was voluntarily.

Ethical considerations

According to the Dutch legislation, neither obtaining informed consent nor approval by a medical ethics committee was obligatory for doing research within the DHCCP [43, 44]. Data analysis was conducted with pseudonymized data, according to the privacy regulations of the DHCCP, in compliance with the General Data Protection Regulation (GDPR) [44]. The privacy of the panel members was protected. All data was carefully stored by Nivel [43]. Personal information such as addresses were stored separately from the data of the questionnaires [43]. Privacy of the panel members in study sample was guaranteed by DHCCP [43]. The researcher (LS) who analyzed the data had no access to the personal information of the panel members [43].

Data collection

Data on the population's perspective on e-health was collected via the DHCCP as part of a larger monitoring study into the perceptions, experiences and usage of e-health in The Netherlands [43]. A questionnaire was developed and reviewed by a team of representatives from the healthcare field in the Netherlands. The questionnaire was based upon earlier distributed questionnaires of the monitoring study and was adjusted to reflect market developments [34]. The questionnaire was distributed via email and post (according to preferences of the panel members) in May 2021. A digital reminder was sent after one, two and three weeks after the start of the questionnaire and one written reminder was sent after two weeks. Panel members had four weeks to respond.

Socio-economic position indicators

The concept of SEP is complex, as it results from the interaction between individual, social, economic, cultural, and societal factors [45, 46]. In this study, three different operationalizations of SEP were used to study the digital divide in the context of e-health: education as a historic starting point, standardized household income as a measure of current wealth and SES level of the neighborhood to include environmental influence [46-49].

Education

The education levels were defined as follows: low (none, primary school or pre-vocational education) (1); medium (secondary or vocational education level 1, 2, 3 or 4) (2); and, high (professional higher education or university) (3) [50].

Standardized income

Standardized income was defined as the net monthly income of the household adjusted for number of household members. The net income was converted to the equivalent of the net income of a single adult household by using equivalence factors from Statistics Netherlands (the Dutch Institute for Population Statistics) [51]. Some respondents acknowledged having children or other adults living in their household apart from their partner or children above 18 but did not specify the number. In this case, the following assumption, in line with the Dutch average, was made: 1.57 children and/or 1 extra adult [50, 52, 53]. Information gathered from the panel members about their monthly net income was in ranges, and the mean of the range was taken as the monthly net income. Standardized income was divided in three categories, low (between 0 – 1659 euro per month) (1); medium (between 1660 – 2332 euro per month) (2); and high (more than 2332 euro per month) (3). The categories were derived from the quartile distribution of the net income of Dutch households (2020) [54].

Socio-economic status level of the neighborhood

The SES level of the neighborhood of all respondents was determined using the SES-WOA score (2019) from Statistics Netherlands. The SES-WOA score was based on the wealth, the educational status and the recent employment history of households in the neighborhood [55, 56]. The SES-WOA score was matched to the respondent by the four-digit postal code. The neighborhoods of the respondents were categorized as: low (first tertile of SES score [-0.89 – 0.042]) (1); medium (second tertile of SES score [0.043 – 0.21]) (2); and high (third tertile of SES score [0.21 – 0.71]) (3). The average score of Dutch neighborhoods was 0.092 (SD: 0.23, min-max: -0.89 – 0.71) [55, 56].

E-health and the digital divide

For the interpretation of the data the Digital Divide model was utilized. The Digital Divide model published by van Dijk et al. conceptualized that individuals' SEP influences the available resources to access, use and benefit from new digital media [57]. In this study, the digital media in focus was e-health.

Two concepts of e-health were examined: 1) E-health in general and 2) Websites, apps and wearables. Items in the questionnaire that informed these two concepts were matched to the three levels of the Digital Divide model [57], namely level 1) access, level 2) use, and level 3) perceived benefit. Operationalization of the variables measuring access, use and perceived benefit for e-health in general and websites, apps and wearables can be found in Appendix 1.

First, e-health in general was studied to gain insight into an overall interest towards digital applications in healthcare. The following levels of digital divide were studied: access and the perceived benefit. Access was measured by motivation, here respondents were asked what their general thoughts are about digital applications used in healthcare. Perceived benefit was operationalized by measuring to what extend the respondents perceived themselves making more conscious decisions about their health as a result of e-health use.

Second, e-health in terms of websites, apps and wearables was studied to gain insight into the use of these specific e-health tools to improve health or providing support in coping with a disease. The following digital divide levels were taken into account: access and use. Access was measured by motivation and physical access. Motivation was measured by asking the respondents if they have used or would like to use websites, apps and/or wearables for their health. For physical access the respondents were asked if they have access to an electronic device with internet.

The digital divide concept use was measured by barriers in use, diversity of use and frequency of use. For the concept barriers in use, the respondents were asked if they experienced barriers in the use of websites, apps and/or wearables. Use of websites, apps and wearables was further operationalized in two variables: diversity of use and frequency of use. For these variables the respondents were asked about 16 different websites, apps or wearables if they used the application

(once or more than once). Diversity entails the variety of websites, apps and/or wearables used, while the frequency of use operationalizes the number of times (more than once) the applications were used.

Statistical analysis

Descriptive analyses were used to describe the demographics and the outcome of the variables measuring access, use and perceived benefit for e-health in general and websites, apps and wearables. The variables measuring access, use and perceived benefit were constructed by combining items from the original questionnaire. Operationalization of these variables can be found in Appendix 1.

The outcomes were stratified by the three variables of SEP: educational level, standardized income and SES level of the neighborhood. The differences of e-health access and usage between SEP populations were investigated using logistic regression analysis. Ordered logistic regression was used for testing the differences in perceived benefit between SEP populations. Age was included in the analysis to test for confounding, as age is associated with both health, and familiarity and use of digital media [10, 58, 59]. Correlation between the independent variables were determined via Spearman's Rank-Order Correlation coefficient. Data analysis was conducted using Stata Statistical Software release 16.1 [60]. A $P<.05$ was considered statistically significant. Variables physical access and diversity of use were not included in the logistic regression analysis because there were too few cases in outcome categories to meet the assumptions of the logistic regression analysis. The univariate outcomes are presented in Appendix 2.

Results

Sample characteristics

In total, 849 panel members responded to the questionnaire, resulting in a response rate of 56.6% (849/1500). Among the panel population of 1500, 8.9% (133/1500), 40% (600/1500) and 48.7% (731/1500) had low, medium and high level of education, respectively. Of these groups, 55.6% (74/133), 59.3% (356/600) and 54.3% (397/731) responded to the questionnaire. Regarding standardized income 35.8% (537/1500), 31.8% (477/1500) and 27.9 (419/1500) had low, medium and high level of standardized income, respectively. Of these groups, 57.2% (307/537), 56.4% (269/477) and 54.9% (230/269) had responded to the questionnaire. Lastly, for SES-level of the neighborhood, 42.8% (642/1500), 32.6% (489/1500) and 23.1% (346/1500) had low, medium and high level of SES-level of the neighborhood in the panel population, respectively. Of these groups, 56.1% (360/642), 58.1% (284/489) and 55.2% (191/346) responded to the questionnaire.

The demographics of the study population can be found in Table 1. An overview of the study population stratified by education, standardized income and SES level of the neighborhood can be found in Appendix 3. Overall, the sample contained the same distribution of males/females as in the general population. When stratified for age category, our sample contained slightly more 40+ respondents and fewer 18-39 respondents as compared to the general population. A frequency table of males and females in three age categories from the study population and the general Dutch population can be found in Appendix 4. Compared to the Dutch general population, the study population had more males (11% general population, 15% study population) and females (13% general population, 15% study population) in the age category 65+. In terms of sex, the distribution was equal between both populations (49% male, 51% female).The mean age was 54 years. The lowest number of respondents was in the low educational level subpopulation (74/849, 8.72%) and the highest in the high educational level subpopulation (397/849, 46.76%). A high educational level was significantly and positively associated with a high standardized income level, as indicated by the following correlations: educational level and standardized income level: $\rho=0.37$ ($P<.001$), educational level and SES level of the neighborhood: $\rho= 0.021$

(*P*=0.55), standardized income level and SES level of the neighborhood: ρ= 0.035 (*P*=0.33) [61].

Table 1. Demographic description of the study population (n=849). Study population was sampled (2021) from a representative population (n=1500) of general Dutch population aged 18 and above. Education level: low (none, primary school or pre-vocational education) ; medium (secondary or vocational education level 1, 2, 3 or 4) (2); and, high (professional higher education or university) (3). Standardized income was divided in three categories, low (between 0 – 1659 euro per month) (1); nedium (between 1660 – 2332 euro per month) (2); and high (more than 2332 euro per month). The SES level of the neighborhood was determined using the SES-WOA score (2019) from Statistics Netherlands. The SES-WOA score was based on the wealth, the educational status and the recent employment history of households in the neighborhood [55, 56]. Categories: low (first tertile of SES score [-0.89 – 0.042]) (1); medium (second tertile of SES score [0.043 – 0.21]) (2); and high (third tertile of SES score [0.21 – 0.71]) (3). [a]

		Total
		n=849
Sex, n (%)		
	Male	413 (48.6)
	Female	435 (51.2)
	Missing	1 (0)
Age, mean (SD, range)		54 (16.96, 19-92)
Average household size, mean (SD, range)		2.29 (1.11, 1-7)
Number of households with children below 18, n (%)		
	No	604 (71.1)
	Yes	235 (27.7)
	Missing	10 (1.2)
Number of households with children above 18, n (%)		
	No	763 (89.9)
	Yes	76 (9)
	Missing	10 (1.2)
Education		
	Mean (SD, range)	2.39 (0.65, 1-3)
	Low, n (%)	74 (8.7)
	Medium, n (%)	356 (41.9)
	High, n (%)	397 (46.8)
	Missing (%)	22 (2.6)
Standardized income		
	Mean (SD, range)	1.90 (0.81, 1-3)
	Low, n (%)	307 (36.2)
	Medium, n (%)	269 (31.7)
	High, n (%)	230 (27.1)
	Missing (%)	43 (5.1)
SES level of the neighborhood		
	Mean (SD, range)	1.80 (0.79, 1-3)
	Low, n (%)	360 (42.4)
	Medium, n (%)	284 (33.5)
	High, n (%)	191 (22.5)
	Missing (%)	14 (1.7)

[a] Not all values add up to 100% due to missing values.

Results of the relation between the digital divide levels and the socio-economic position indicators

An overview of the measured and analyzed variables can be found in Figure 1. The variables physical access and diversity of use for websites, apps and wearables were not analyzed because these variables could not meet the assumptions for logistic regression analysis. The frequencies of these outcomes can be found in Appendix 2. Table 2 presents a descriptive overview of access, use and perceived benefit, stratified by SEP indicators. The results showed that the outcome differed the most when the population was stratified by education. Figure 2 presents the associations between access, use and perceived benefit and low, medium and high education, standardized income and SES level of the neighborhood populations. The underlying data used for Figure 2 is presented in Appendix 5.

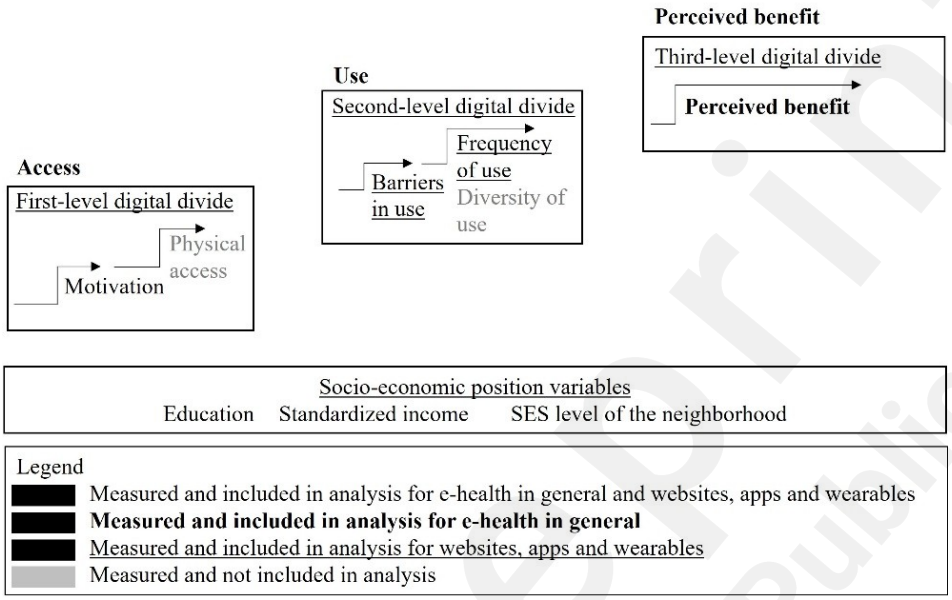

Figure 1. Overview of the concepts access, use and perceived benefit, the variables matched to these concepts and the socio-economic position indicators used in this study. Legend indicates whether the variables were matched for e-health in general (bold), websites apps and wearables (underlined) or both. Secondly, the legend indicates whether the variables were viable, either included (black) or not included (grey), for logistic (ordered) regression analysis. Adapted from Jan van Dijk (2020), The Digital Divide p.64 [57]. SES: socio-economic status.

Access and motivation

For e-health in general, as well as for websites, apps and wearables, differences in motivation were found between different levels of education. Differences in motivation were most profound between low/medium vs highly educated respondents in both e-health in general (OR 2.18, 95% CI 1.22 -3.88) and websites, apps and wearables (OR 5.72 (95% CI 3.06 – 10.72). Regarding standardized income, difference in motivation for e-health in general was found between high and low standardized income (OR 1.52, 95% CI 1.05 – 2.21). A significant difference in motivation between low (OR 1.74, 95% CI 1.19 – 2.55) and medium (OR 1.63, 95% CI 1.1 – 2.43) vs high SES level of the neighborhood was found for e-health in general.

Use, barriers in use and experienced barriers

High standardized income was associated with no experience of barriers in use in comparison to low and medium levels of standardized income. This implies that fewer respondents with a high standardized income experienced barriers while

using e-health websites, apps and/or wearables (OR 1.60, 95% CI 1.11 – 2.31). Frequency of e-health use also differed between respondents with a low, medium or high level of education, with the most significant difference between high and low educational levels (OR 4.96, 95% CI 2.66 – 9.24). In terms of standardized income, there were significant differences between low and high (OR 1.76, 95% CI 1.06 – 2.91) and low and medium (OR 1.74, 95% CI 1.09 – 2.79) standardized income levels. High SEP respondents were more likely to frequently use of an e-health application, website or wearable compared to medium or low SEP respondents.

Perceived Benefit

There were no significant differences found regarding the perceived benefits between low, medium or high SEP populations.

Table 2. Frequency distribution of access, use and perceived benefit for 1) e-health in general and 2) websites, apps and wearables, stratified by education, standardized income and SES level of the neighborhood. Frequencies are derived from results of a questionnaire (2021) conducted among a sample of the general Dutch population (n=1500). Final study population (n=849).[b,c, d]

	Total	Education			Standardized income			SES level of the neighborhood		
		Low	Med	High	Low	Med	High	Low	Med	High
Population (n)	849	74	356	397	307	269	230	360	284	191
E-health in general										
Access – Motivation, n (%)										
No motivation	386 (45.5)	46 (62.2)	177 (49.7)	152 (38.3)	153 (49.8)	124 (46.1)	90 (39.1)	174 (48.3)	141 (49.6)	68 (35.6)
Motivation	401 (47.2)	21 (28.4)	153 (43)	218 (54.9)	131 (42.7)	127 (47.2)	123 (53.5)	157 (43.6)	127 (44.7)	107 (56)
Perceived benefit – Perceived benefit, n (%)										
Totally disagree – disagree	211 (24.9)	17 (23)	80 (22.4)	108 (27.2)	70 (22.8)	68 (25.3)	65 (28.3)	85 (23.6)	76 (26.7)	46 (24.1)
Not agree nor disagree	370 (43.6)	33 (44.5)	171 (48)	159 (40.1)	144 (46.9)	119 (44.2)	89 (38.7)	158 (43.9)	134 (47.2)	75 (39,3)
Agree – totally agree	205 (24.1)	17 (23)	81 (22.8)	104 (26.2)	69 (22.5)	65 (24.2)	61 (26.5)	87 (24.2)	61 (21.5)	53 (27.7)
Websites, apps and wearables										
Access –										

[b] The variables physical access and diversity of use for websites, apps and wearables were not presented in Table 2 because these variables could not meet the assumptions for logistic regression analysis. The frequencies of these outcomes can be found in Appendix 2.

[c] Not all values add up to 100% due to missing values.

[d] SES: socio-economic status; Med: medium level

	Total	Education			Standardized income			SES level of the neighborhood		
		Low	Med	High	Low	Med	High	Low	Med	High
Population (n)	849	74	356	397	307	269	230	360	284	191
Motivation, n (%)										
No motivation	143 (16.8)	35 (47.3)	62 (17.4)	41 (10.3)	59 (19.2)	43 (16)	34 (14.8)	65 (18.1)	50 (17.6)	23 (12)
Motivation	636 (75)	29 (39.2)	265 (74.4)	328 (82.6)	221 (72)	206 (76.6)	178 (77.4)	263 (73.1)	215 (75.7)	150 (78.5)
Use – Barriers in use, n (%)										
Experienced barriers	339 (40)	29 (39.2)	140 (39.3)	159 (40.1)	135 (44)	109 (40.5)	76 (33)	145 (40.3)	119 (41.9)	71 (37.2)
No experienced barriers	472 (55.6)	39 (52.7)	201 (56.5)	223 (56.2)	157 (51.1)	149 (55.4)	145 (63)	197 (54.7)	156 (54.9)	110 (57.6)
Use – Frequency of use, n (%)										
No frequent use	131 (15.4)	29 (39.2)	60 (16.9)	38 (9.6)	59 (19.2)	36 (13.4)	29 (12.6)	57 (15.8)	47 (16.5)	24 (12.6)
Frequent use	662 (78)	34 (45.9)	274 (77)	339 (85.4)	222 (72.3)	219 (81.4)	189 (82.2)	277 (76.9)	226 (79.6)	149 (78)

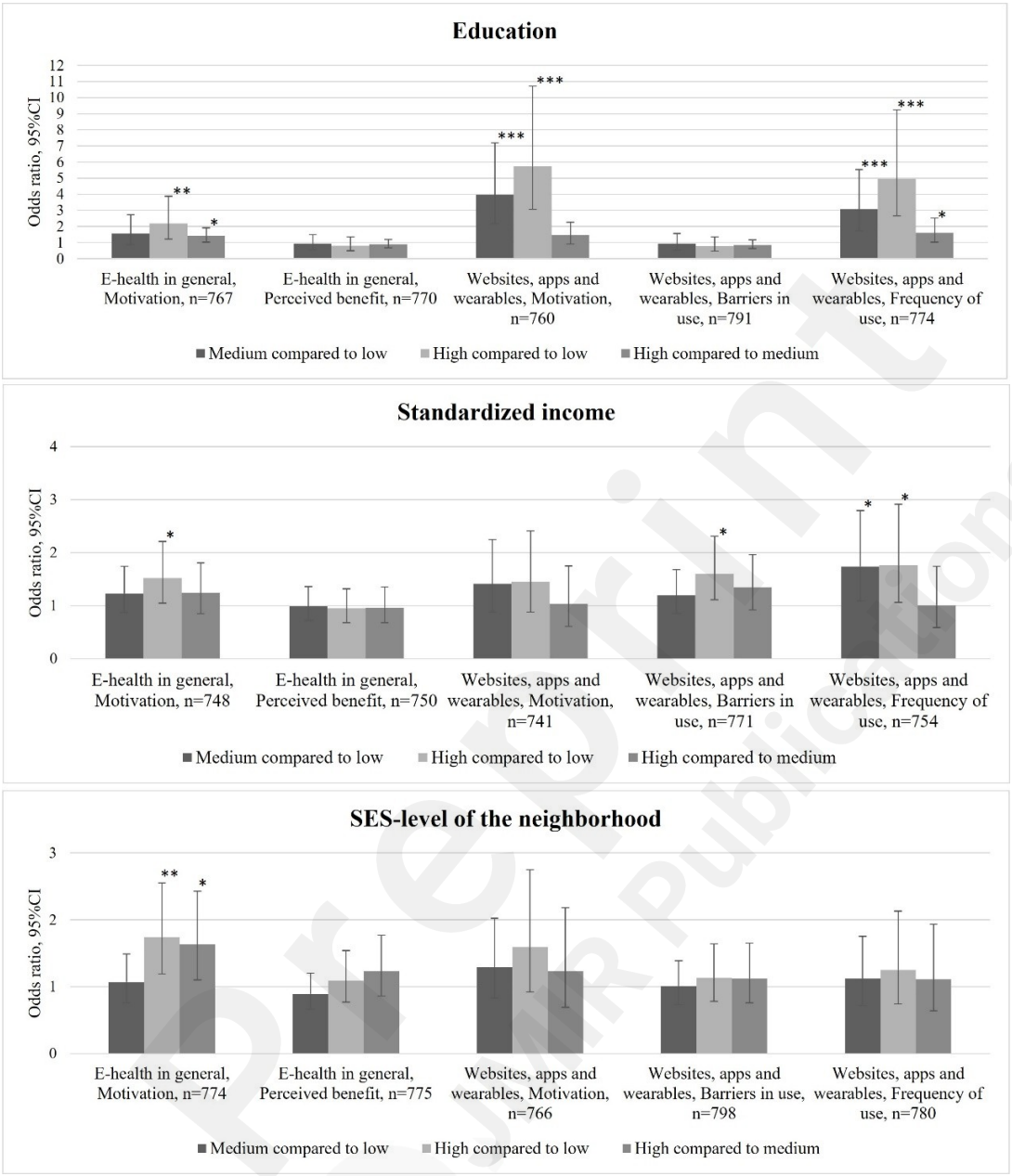

Figure 2. The relation between access, use and benefit of e-health and low, medium and high levels of three SEP indicators: education, standardized income and SES-level of the neighborhood. Results from a questionnaire (2021) answered by a representative study population (n=849) for the general Dutch population aged 18 and above. Access: motivation, use: barriers in use and frequency of use, and perceived benefit: perceived benefit. For each SEP indicator, a bar graph of the results of logistic (ordered) regression analysis was presented. Each bar shows the odds ratio and the 95% CI for the difference between SEP levels for each digital divide concept. For each SEP indicator, the following comparisons were made: medium compared to low (dark grey), high compared to low (light grey) and high compared to medium (medium grey). The number of respondents (n=) included in the analysis for each digital divide concept was indicated. The variable barriers in use was recoded to ensure that positive score (1) reflected the outcome: no experienced barriers. Positive odds ratios (OR>1) should be interpreted that the primary group in the comparison, in the case of this study either medium of high SEP, had more likelihood to not experience barriers in use. *P>0.05, **P>0.01, ***P>0.001. SEP: socio-economic position; SES: socio-economic status; CI: confidence interval.

Discussion

This study shows that low SEP respondents have less access and use of e-health compared to medium or high SEP respondents. The most significant digital divide observed in this study is related to educational background. The results of this paper contribute on a population level to previous findings that the access and use of e-health has a socio-economic gradient. Additionally, the results emphasize that SEP indicators cannot be used interchangeably to assess e-health access and use.

The results of this study highlight that, across all three SEP indicators, the most substantial differences are found in access through motivation. Respondents from higher socio-economic categories expressed greater motivation to utilize e-health, including websites, apps, and wearables, in comparison to those from lower socio-economic positions. Health equity researchers emphasize that comprehending how people perceive health and healthcare is a complex issue influenced by several societal, contextual, social, and biological individual factors. Therefore, a multi-dimensional and multi-causal approach is necessary to comprehend these disparities [24, 62, 63]. Weiss *et al.* discuss existing literature and multiple theories to why differences in e-health access and use exist between socio-economic groups [28]. The literature described that the social position of individuals and the influence of the context and organizations surrounding the individual play a role whether individuals choose to consume digital healthcare or not [28]. Other literature emphasized that the diffusion of digital healthcare in society will decrease the digital divide gap as the low SEP population is assumed to be the latest to adopt [28]. However, the role of healthcare organizations, social policies, and political decisions that impact individuals' motivations towards e-health has not been adequately studied. Current national Dutch policies concerning e-health are focused on the development and interoperability of e-health applications, the digital skills of health care professionals and the use of e-health by elderly at home, resulting in e-health to become an essential part of the healthcare system [64]. In countries where healthcare digitalization is progressing, it would be valuable to examine the potential influence of the government, healthcare organizations, and businesses on the motivation of low socio-economic populations towards e-health. Such research could offer valuable insights into the societal and policy changes required to make e-health more appealing to low SEP populations.

In this study, use was examined by studying the barriers in use and frequency of use of e-health websites, apps and/or wearables. The results demonstrated that respondents with a high standardized income level infrequently experienced barriers with using e-health websites, apps and/or wearables compared to lower standardized income levels. Previous studies show that highly educated people often have higher (health) literacy levels and digital skills and are more in contact with the digital world via their education or profession [10, 31, 59, 65-69]. Other studies show that in the development of e-health new applications are often pilot-tested by highly educated respondents and therefore, might be more tailored to the needs of highly educated individuals [9, 70, 71]. In contrast, other studies point out the variety of health behaviors and healthcare use within SEP groups. De Boer *et al.* show that low SEP groups have more healthcare cost but that healthy lifestyle behaviors such as smoking or being member of a sport club is attributing greatly to the variety in healthcare use in each socio-economic group [72]. In the light of e-health, Agachi *et al.* showed that the user interface and the type of e-health offered attributes to the use of e-health between socio-economic groups [73]. Results revealed that for the same e-health program, people living in a low socio-economic neighborhood use the app-based tool more than people living high in a socio-economic neighborhood. For the web-based version, results show the opposite emphasizing the importance of the user-interface and the accessibility to digital devices, as is also theorized in

the Digital Divide model [49, 73]. Both De Boer and Agachi show that behavior-related and technical-related factors play a role in the use of healthcare and e-health [72, 73]. The results of this study and other studies showed that understanding and creating insight into the existence of and possible solutions for health disparities is dependent on multiple dimensions. Future research to how the socio-economic gradient in e-health access and use are associated with other behavioral and technical factors is important to create in-depth understanding of disparities in e-health access and use that can inspire research, policy and practice.

Results pointed out that high education and high standardized income levels were associated with frequent use of websites, apps and/or wearables. This is in accordance with previous research, which shows that a high level of education and income is found to be associated with more access to and use of e-health [12, 13, 31]. Surprisingly, no difference was found in the perceived benefits (making more conscious decisions in health because of e-health use) in any of the SEP indicators, although the frequency of use of websites, apps and wearables was high (78%) and did show significant differences. This implies that respondents with a more frequent use of websites, apps and wearables had the same perceived benefit, namely: making more conscious decisions due to e-health use, compared to respondents who have not used websites, apps and wearables once. Evaluation studies show that high SEP respondents have better outcomes from e-health use than low SEP respondents [10, 30, 31, 59]. The results of this study might indicate that in the real-life context, even though current e-health applications might be more suitable for highly educated individuals, e-health is not used appropriately or with similar discipline as in the clinical trial context.

Strengths and limitations

Strengths of this study were the use of a large and representative sample of the Dutch population and the use of three SEP operationalizations to provide a broad insight in the effects of SEP on the digital divide. This study also has some limitations. Despite a large number of respondents, the skewed distribution of outcomes across SEP levels hampered the performance of multivariable logistic regression analysis [61]. Next to this, the SEP indicators used are focused on social demographic and economic aspects of SEP, cultural and other social aspects, such as social network and cultural background, have not been taken into account.

The questionnaire used in the study was not designed to measure all the different aspects of the digital divide model and is a secondary analysis of the data gathered. Although the majority of digital divide levels could be well matched with questionnaire items, data on the second level digital divide for e-health in general and the third digital divide level for websites, apps and wearables was lacking. In some cases, with emphasis on the concept barriers in use for websites, apps and wearables more in depth insights in the digital divide levels would have been desirable to improve validation of the findings. Van Dijk (2020) provides concepts to further define the digital divide levels [57]. Access, the first level digital divide, is described to entail the concepts motivational access and physical access. Use, the second level digital divide, entails the concepts digital skills and usage. Usage here encompasses both frequency and diversity of digital media use. Perceived benefit, the third level digital divide, is conceptualized by personal outcomes that are a result of the use of digital media [57]. In this study, the concept barriers in use was used instead of digital skills, as experienced barriers are not limited to barriers formed by (lack of) digital skills.

Additionally, for the first and the second level digital divide, the technical design and the Information- and Communication Technology (ICT) of e-health are of importance [57]. The technical design and the ICT imply factors such as accessibility, usability, mobility, quality and accessibility of internet access and, automation (self-

learning devices or software tailored to serve the consumer better and automatically) of devices and applications. These factors are important to facilitate adherence and appropriate use of e-health applications [57]. The questionnaire provided no insight into these factors.

Conclusion

Results of this study revealed that differences in motivation for e-health use is most profound between different socio-economic populations in the Dutch society, in which low educated people are likely to be disadvantaged. A successful transition towards digital healthcare is a social issue which is dependent on motivation to use e-health and specific applications. It is imperative that future studies within academia and within the healthcare field focuses on the motivations and needs associated with digital healthcare, specifically for low SEP populations. Research to the societal changes stemming from the digital healthcare transition and the technical and design studies of digital care applications in single-intervention studies are both vital for the realization of an inclusive and comprehensive digital healthcare system. If e-health takes a predominant role in the Dutch healthcare system, it might affect access and utilization of healthcare for the citizens who need it most. The results of this study underscore the importance of policies aimed at facilitating and supporting low SEP populations in the use of e-health to reduce differences in health.

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Data availability

The minimal anonymized data set is accessible upon request from prof. Judith D. de Jong (j.dejong@nivel.nl), project leader of the Dutch Health Care Consumer Panel, or the panel's secretary (conusmentenpanel@nivel.nl). The DHCCP has a program committee which supervises processing the data of the DHCCP, approves requests for use of the panel for research purposes and decides about the use of the data. The committee assesses whether research and data requests fit within the aim of the DHCCP, which is to strengthen the position of the health care user. This program committee consists of representatives of the Dutch Ministry of Health, Welfare and Sport, the Health Care Inspectorate, Zorgverzekeraars Nederland (Association of Health Care Insurers in the Netherlands), the National Health Care Institute, the Federation of Patients and Consumer Organisations in the Netherlands, the Dutch Healthcare Authority and the Dutch Consumers Association.

Conflict of interest

None to declare.

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Appendices

Appendix 1 – Operationalization of access, use and perceived benefit of e-health in general and websites, apps and wearables. Questions from a questionnaire conducted in 2021 among a sample of the Dutch population (n=1500) were matched to the concepts access, use and perceived benefit. Some of these concepts were measured by multiple variables. Access: motivation and physical access; perceived benefit: perceived benefit; and use: barriers in use, frequency of use and diversity of use.

Model stage	Question to respondents	Answer categories	Recoding of answers
E-health in general			
Access – Motivation	What are your general thoughts about digital applications in healthcare?	1. I'm very enthusiastic 2. I would like to try 3. I have to work with it because it's best for my health 4. I have to work with it because it's part of the modern times we live in 5. I'm contemplating about what is best for me 6. I am reluctant 7. I do not see added value 8. I am very negative	- Negative motivation (0) if answer category 5, 6, 7 or 8 was checked - Positive motivation (1) if answer category 1,2,3 or 4 was checked
Perceived benefit – Perceived benefit	Digital applications in healthcare can lead to me making more conscious decisions for my health	1. Totally disagree 2. Disagree 3. Neutral 4. Agree 5. Totally agree	- Totally disagree – disagree (1) if answer category 1 or 2 was checked - Neutral (2) if answer category 3 was checked - Agree – totally agree (3) if answer category 4 or 5 was checked
Websites, apps and wearables			
Access – Motivation	In the last twelve months I have: 1. Used an app for my health or treatment 2. Used a wearable (such as a smartwatch) for my health or treatment 3. Visited a website for my	For each question: 1. Yes, once 2. Yes, often 3. No. and I don't want to 4. No, and I don't know if I want to 5. No, but I would want to	- Negative motivation for e-health applications (0) if for each question answer category 3 or 4 were checked.

Model stage	Question to respondents	Answer categories	Recoding of answers
	health or treatment		- Positive motivation for one out of three e-health applications (1) if for one question the answer category 1, 2 or 5 was checked
Access – Physical access	Do you possess a computer, phone or tablet with internet?	1. Yes 2. No	- No physical access (0) if answer category 2 was checked - Physical access (1) if answer category 1 was checked
Use – Barriers in use	While using websites, apps and/or wearables I experience:	1. No constraining factors 2. Constraining factors	- Barriers in use (0) if answer category 2 was checked - No barriers in use (1) if answer category 1 was checked
Use – Diversity of use and frequency of use	In the last twelve months I have: 1. Searched for information via websites or apps about: a. A disease or treatment b. The corona virus c. If I should go to the doctor with a certain problem d. Lifestyle such as nutrition, physical exercise and/or mental health 2. Tracked data by myself via websites or apps: a. On my doctors' visits or treatments	For each question: 1. Yes, once 2. Yes, often 3. No. and I don't want to 4. No, and I don't know if I want to 5. No, but I would want to	Diversity of use: - No use of any type of websites, apps and wearables (0) if for all the questions answer category 3, 4 or 5 were checked - Use of 1 or more websites, apps and wearables (1) if for one of the questions answer category 1 or 2 was checked Frequency of use: - No frequent use of any type of websites, apps and

Model stage	Question to respondents	Answer categories	Recoding of answers
	b. On my nutrition or diet c. On my physical exercise (such as a pedometer) 3. Followed (anonymously) a treatment via a website or apps a. To quit an addiction such as smoking, alcohol or drug abuse b. For treatment of psychological problems such as stress management or sleep improvement c. To learn how to apply healthy/healthier behavior d. To learn how to manage the consequences of a disease 4. Used equipment that regularly measures health data such as blood pressure or glucose levels. 5. Used an automatic reminder to take my medication via my phone or tablet. 6. Played a computer game to a. To learn how to apply healthy/healthier behavior b. To learn how to manage the		wearables (0) if for all the questions answer category 1, 3, 4 or 5 were checked - Frequent use of one or more websites, apps and wearables (1) if for one of the questions answer category 2 was checked

Model stage	Question to respondents	Answer categories	Recoding of answers
	consequences of a disease 7. Watched online instruction video's (for example via YouTube) that help me with my nutrition, physical exercise or (mental) health.		

Appendix 2 – Frequency table of the outcomes of access, use and perceived benefit for e-health in general and websites, apps and wearables gathered via a questionnaire (2021). Questionnaire was conducted among a study population (n=849) drawn from a representative population (n=1500) of the general Dutch population aged 18 and above. Access: motivation and physical access; perceived benefit: perceived benefit; and use: barriers in use, frequency of use and diversity of use. Outcomes were stratified by education, standardized income an SES level of the neighborhood. Education level: low (none, primary school or pre-vocational education) ; medium (secondary or vocational education level 1, 2, 3 or 4) (2); and, high (professional higher education or university) (3). Standardized income was divided in three categories, low (between 0 – 1659 euro per month) (1); nedium (between 1660 – 2332 euro per month) (2); and high (more than 2332 euro per month). The SES level of the neighborhood was determined using the SES-WOA score (2019) from Statistics Netherlands. The SES-WOA score was based on the wealth, the educational status and the recent employment history of households in the neighborhood [55, 56]. Categories: low (first tertile of SES score [-0.89 – 0.042]) (1); medium (second tertile of SES score [0.043 – 0.21]) (2); and high (third tertile of SES score [0.21 – 0.71]) (3). The variables are constructed from items from the original questionnaire. Operationalization of variables can be found in Appendix 1.[e]

	Total	Education			Standardized income			SES level of the neighborhood		
		Low	Medium	High	Low	Medium	High	Low	Medium	High
Population (n)	849	74	356	397	307	269	230	360	284	191
E-health in general										
Access – Motivation, n (%)										
No motivation	386 (45.5)	46 (62.2)	177 (49.7)	152 (38.3)	153 (49.8)	124 (46.1)	90 (39.1)	174 (48.3)	141 (49.6)	68 (35.6)
Motivation	401 (47.2)	21 (28.4)	153 (43)	218 (54.9)	131 (42.7)	127 (47.2)	123 (53.5)	157 (43.6)	127 (44.7)	107 (56)
Benefit – Perceived benefit, n (%)										
Totally disagree – disagree	211 (24.9)	17 (23)	80 (22.4)	108 (27.2)	70 (22.8)	68 (25.3)	65 (28.3)	85 (23.6)	76 (26.7)	46 (24.1)
Not agree nor disagree	370 (43.6)	33 (44.5)	171 (48)	159 (40.1)	144 (46.9)	119 (44.2)	89 (38.7)	158 (43.9)	134 (47.2)	75 (39,3)

[e] Not all percentages add up to a 100% due to rounding or missing values

	Total	Education			Standardized income			SES level of the neighborhood		
		Low	Medium	High	Low	Medium	High	Low	Medium	High
Population (n)	849	74	356	397	307	269	230	360	284	191
Agree - totally agree	205 (24.1)	17 (23)	81 (22.8)	104 (26.2)	69 (22.5)	65 (24.2)	61 (26.5)	87 (24.2)	61 (21.5)	53 (27.7)
Websites, apps and wearables										
Access – Physical access, n (%)										
No	29 (3.4)	13 (17.6)	11 (3.1)	3 (1)	19 (6.2)	6 (2.2)	2 (1)	10 (2.8)	13 (4.6)	5 (2.6)
Yes	816 (96.1)	61 (82.4)	342 (96.1)	393 (99)	287 (93.5)	260 (96.7)	228 (99.1)	347 (96.4)	270 (95.1)	186 (97.4)
Access – Motivation, n (%)										
No motivation	143 (16.8)	35 (47.3)	62 (17.4)	41 (10.3)	59 (19.2)	43 (16)	34 (14.8)	65 (18.1)	50 (17.6)	23 (12)
Motivation	636 (74.9)	29 (39.2)	265 (74.4)	328 (82.6)	221 (72)	206 (76.6)	178 (77.4)	263 (73.1)	215 (75.7)	150 (78.5)
Use – Barriers in use, n (%)										
Experienced barriers	339 (40)	29 (39.2)	140 (39.3)	159 (40.1)	135 (44)	109 (40.5)	76 (33)	145 (40.3)	119 (41.9)	71 (37.2)
No experienced barriers	472 (55.6)	39 (52.7)	201 (56.5)	223 (56.2)	157 (51.1)	149 (55.4)	145 (63)	197 (54.7)	156 (54.9)	110 (57.6)
Use – Diversity of usage, n (%)										
No use	77 (9.1)	23 (31.1)	32 (9)	19 (4.8)	38 (12.4)	19 (7.1)	15 (6.5)	39 (10.8)	25 (8.8)	11 (5.8)
Use	737 (86.8)	46 (62.1)	311 (87.4)	363 (91.4)	253 (82.4)	242 (90)	207 (90)	307 (85.3)	251 (88.4)	168 (88)
Use – Frequency of use, n (%)										
No frequent use	131 (15.4)	29 (39.2)	60 (16.9)	38 (9.6)	59 (19.2)	36 (13.4)	29 (12.6)	57 (15.8)	47 (16.5)	24 (12.6)
Frequent use	662 (78)	34 (45.9)	274 (77)	339 (85.4)	222 (72.3)	219 (81.4)	189 (82.2)	277 (76.9)	226 (79.6)	149 (78)

Appendix 3 – Demographic description of the study population and the study population stratified by levels of education, standardized income and SES level of the neighborhood. Study population (n=849) was sampled from a representative population (n=1500) of the general Dutch population aged 18 and above (2021). Education level: low (none, primary school or pre-vocational education) ; medium (secondary or vocational education level 1, 2, 3 or 4) (2); and, high (professional higher education or university) (3). Standardized income was divided in three categories, low (between 0 – 1659 euro per month) (1); nedium (between 1660 – 2332 euro per month) (2); and high (more than 2332 euro per month). The SES level of the neighborhood was determined using the SES-WOA score (2019) from Statistics Netherlands. The SES-WOA score was based on the wealth, the educational status and the recent employment history of households in the neighborhood [55, 56]. Categories: low (first tertile of SES score [-0.89 – 0.042]) (1); medium (second tertile of SES score [0.043 – 0.21]) (2); and high (third tertile of SES score [0.21 – 0.71]) (3). [f, g]

		Total	Education			Standardized income			SES level of the neighborhood		
Population (n)		849	Low 74	Medium 356	High 397	Low 307	Medium 269	High 230	Low 360	Medium 284	High 191
Sex, n (%)											
	Male	413 (48.6)	39 (52.7)	181 (50.8)	187 (47.1)	137 (44.6)	134 (50)	123 (53.5)	184 (51.1)	135 (47.5)	89 (46.6)
	Female	435 (51.2)	35 (47.3)	175 (49.2)	209 (52.6)	170 (55.4)	134 (50)	107 (46.5)	175 (48.6)	149 (52.5)	102 (53,4)
	Missing	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)
Age, mean (SD, range)		54 (16.96, 19-92)	65.5 (13.24, 33-87)	56.4 (15.73, 19-92)	49.1 (17, 22-89)	54.4 (16.18, 19-92)	54.9 (16.29, 25-88)	51.5 (18.91, 20-89)	53.2 (17.0, 19-92)	55.8 (17.45, 23-88)	52.1 (16, 20-89)
Average household size, mean (SD, range)		2.29 (1.13, 1-6)	1.86 (0.96, 1-5)	2.29 (1.08, 1-7)	2.38 (1.15, 1-6)	2.38 (1.27, 1-7)	2.4 (1.08, 1-5)	1.98 (0.8, 1-3.57)	2.01 (1.02, 1-6)	2.4 (1.11, 1-6)	2.67 (1.16, 1-7)
Number of households with children below 18, n (%)											
	No	604 (71.1)	65 (87.8)	259 (72.8)	268 (67.5)	212 (69.1)	180 (66.9)	195 (84.8)	292 (81.1)	195 (68.7)	110 (57.6)
	Yes	235 (27.7)	8 (10.8)	96 (27)	129 (32.5)	95 (30.9)	89 (33.1)	35 (15.2)	65 (18.1)	88 (31)	80 (41.9)
	Missing	10 (1.2)	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (1)	1 (0)	1 (0)
Number of households with children above 18, n (%)											
	No	763 (89.9)	67 (90.1)	310 (87.1)	372 (93.7)	264 (86)	244 (90.7)	225 (97.8)	330 (91.7)	257 (90.5)	168 (88)
	Yes	76 (9)	6 (8.1)	45 (12.6)	25 (6.3)	43 (14)	25 (9.3)	5 (2.2)	27 (7.5)	26 (9.2)	22 (11.5)
	Missing	10 (1.2)	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (1)	1 (0)	1 (0)
Education											

[f] Maximum of household members for standardized income high is 3.57, this is not a rounded number because 1.57 child was assumed if respondents had children in their household but the number of children was unknown.
[g] Not all percentages add up to a 100% due to rounding or missing values

		Total	Education			Standardized income			SES level of the neighborhood		
Population (n)		849	Low 74	Medium 356	High 397	Low 307	Medium 269	High 230	Low 360	Medium 284	High 191
	Mean (SD, range)	2.39 (0.64, 1-3)	1 (0.00, 1-1)	2 (0.00, 2-2)	3 (0.00, 3-3)	2.12 (0.67, 1-3)	2.43 (0.6, 1-3)	2.71 (0.5, 1-3)	2.39 (0.67, 1-3)	2.35 (0.64, 1-3)	2.46 (0.61, 1-3)
	Low, n (%)	74 (8.7)	74 (100)	0 (0%)	0 (0%)	51 (16.6)	15 (5.6)	5 (2.2)	37 (10.3)	25 (8.8)	11 (5.8)
	Medium, n (%)	356 (41.9)	0 (0%)	356 (100)	0 (0%)	164 (53.4)	122 (45.4)	56 (24.3)	142 (39.4)	132 (46.5)	79 (41.4)
	High, n (%)	397 (46.8)	0 (0%)	0 (0%)	397(100)	88 (28.7)	129 (48)	164 (71.3)	173 (48.1)	122 (43)	97 (51)
	Missing, n (%)	22 (2.6)	0 (0)	0 (0)	0 (0)	4 (1.3)	3 (1.1)	5 (2.2)	8 (2.2)	5 (1.8)	4 (2.1)
Standardized income											
	Mean (SD, range)	2.09 (0.85, 1-3)	1.35 (0.61, 1-3)	1.68 (0.74, 1-3)	2.2 (0.79, 1-3)	1 (0.00, 1-1)	2 (0.00, 2-2)	3 (0.00, 3-3)	1.88 (0.82, 1-3)	1.92 (0.8, 1-3)	1.93 (0.82, 1-3)
	Low, n (%)	307 (36.2)	51 (69)	164 (46.1)	88 (22.2)	307 (100)	0 (0)	0 (0)	140 (38.9)	96 (33.8)	66 (34.6)
	Medium, n (%)	269 (31.7)	15 (20.3)	122 (34.3)	129 (32.5)	0 (0)	269 (100)	0 (0)	109 (30.3)	96 (33.8)	61 (31.9)
	High, n (%)	230 (27.1)	5 (6.8)	56 (15.7)	164 (41.3)	0 (0)	0 (0)	230 (100)	98 (27.2)	75 (26.4)	56 (29.3)
	Missing, n (%)	43 (5.1)	3 (4.1)	14 (3.9)	16 (4)	0 (0)	0 (0)	0 (0)	13 (3.6)	17 (6)	8 (4.2)
SES level of the neighborhood											
	Mean (SD, range)	1.82 (0.8, 1-3)	1.66 (0.75, 1-3)	1.83 (0.78, 1-3)	1.82 (0.81, 1-3)	1.78 (0.8, 1-3)	1.83 (0.79, 1-3)	1.82 (0.8, 1-3)	1 (0.00, 1-1)	2 (0.00, 2-2)	3 (0.00, 3-3)
	Low, n (%)	360 (42.4)	37 (50)	142 (39.9)	173 (43.6)	140 (45.6)	109 (40.5)	98 (42.6)	360 (100)	0 (0)	0 (0)
	Medium, n (%)	284 (33.5)	25 (33.7)	132 (37.1)	122 (30.7)	96 (31.3)	96 (35.7)	75 (32.6)	0 (0)	284 (100)	0 (0)
	High, n (%)	205 (24.1)	12 (16.2)	82 (23)	102 (25.7)	71 (23.1)	64 (23.8)	57 (24.8)	0 (0)	0 (0)	191 (100)
	Missing, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Appendix 4. Frequency table of males and females aged above 18 in three age categories of the Dutch general population (2021) and the study population (2021). Study population (n=849) was sampled from a representative population (n=1500) of the general Dutch population aged 18 and above (2021). M: male; F: female. [h, i]

	Dutch general population		**Study population**	
Sexe (%)	M(%)	F(%)	M(%)	F(%)
Age category				
18 - 39 years of age	17%	17%	12%	13%
40 - 64 years of age	21%	21%	22%	23%
65 years of age and older	11%	13%	15%	15%
Total	49%	51%	49%	51%

[h] Frequencies of the Dutch population were retrieved from Statistics Netherlands [74].

[i] The sex of one participant in the study population was unknown, this participant was excluded from this comparison.

Appendix 5. Results from logistic (ordered) regression analysis. The odds-ratio between access, use and perceived benefit from e-health in general and websites, apps and wearables and the socio-economic position indicators. Logistic ordered regression analysis was used for perceived benefit. Questionnaire was conducted among a study population (n=849) drawn from a representative population (n=1500) of the general Dutch population aged 18 and above. Access: motivation and physical access; perceived benefit: perceived benefit; and use: barriers in use, frequency of use and diversity of use. Outcomes were stratified by education, standardized income an SES level of the neighborhood. Education level: low (none, primary school or pre-vocational education) ; medium (secondary or vocational education level 1, 2, 3 or 4) (2); and, high (professional higher education or university) (3). Standardized income was divided in three categories, low (between 0 – 1659 euro per month) (1); nedium (between 1660 – 2332 euro per month) (2); and high (more than 2332 euro per month). The SES level of the neighborhood was determined using the SES-WOA score (2019) from Statistics Netherlands. The SES-WOA score was based on the wealth, the educational status and the recent employment history of households in the neighborhood [55, 56]. Categories: low (first tertile of SES score [-0.89 – 0.042]) (1); medium (second tertile of SES score [0.043 – 0.21]) (2); and high (third tertile of SES score [0.21 – 0.71]) (3). [j,k,l]

	E-health in general				Websites, apps and wearables					
	Access		Perceived benefit		Access		Use			
	Motivation		Perceived benefit		Motivation		Barriers in use		Frequency in use	
	n	OR (CI95)	n	OR (CI95)	n	OR (CI95)	n	OR (CI95)	n	OR (CI95)
Education	767		770		760		791		774	
Medium (comparison population low)		1.55 (0.87 - 2.74)		0.92 (0.56 - 1.50)		3.95 (2.17 - 7.2) ***		0.92 (0.54 - 1.57)		3.08 (1.72 - 5.54) ***
High (comparison population low)		2.18 (1.22 - 3.88)**		0.81 (0.49 - 1.35)		5.72 (3.06 - 10.72) ***		0.79 (0.46 - 1.36)		4.96 (2.66 - 9.24) ***
High (comparison population medium)		1.41 (1.03 - 1.92)*		0.89 (0.67 - 1.18)		1.45 (0.92 - 2.27)		0.86 (0.63 - 1.17)		1.61 (1.03 - 2.52)*
Standardized income	748		750		741		771		754	
Medium (comparison population low)		1.23 (0.87 - 1.74)		0.99 (0.72 - 1.36)		1.41 (0.88 - 2.25)		1.19 (0.85 - 1.68)		1.74 (1.09 - 2.79)*
High (comparison population low)		1.52 (1.05 - 2.21) *		0.95 (0.68 - 1.32)		1.45 (0.88 - 2.41)		1.60 (1.11 - 2.31) *		1.76 (1.06 - 2.91)*
High (comparison population medium)		1.24 (0.85 - 1.81)		0.96 (0.68 - 1.35)		1.03 (0.61 - 1.75)		1.34 (0.92 - 1.96)		1.01 (0.59 - 1.74)
SES level of the neighborhood	774		775		766		798		780	
Medium (comparison population low)		1.07 (0.76 - 1.49)		0.89 (0.66 - 1.2)		1.29 (0.83 - 2.02)		1.01 (0.73 - 1.39)		1.12 (0.72 - 1.75)
High		1.74		1.09		1.59		1.13		1.25

[j] The variables physical access and diversity of use for websites, apps and wearables were not presented because these variables had too few cases in stratified outcome categories to meet the assumptions of the regression analyses.

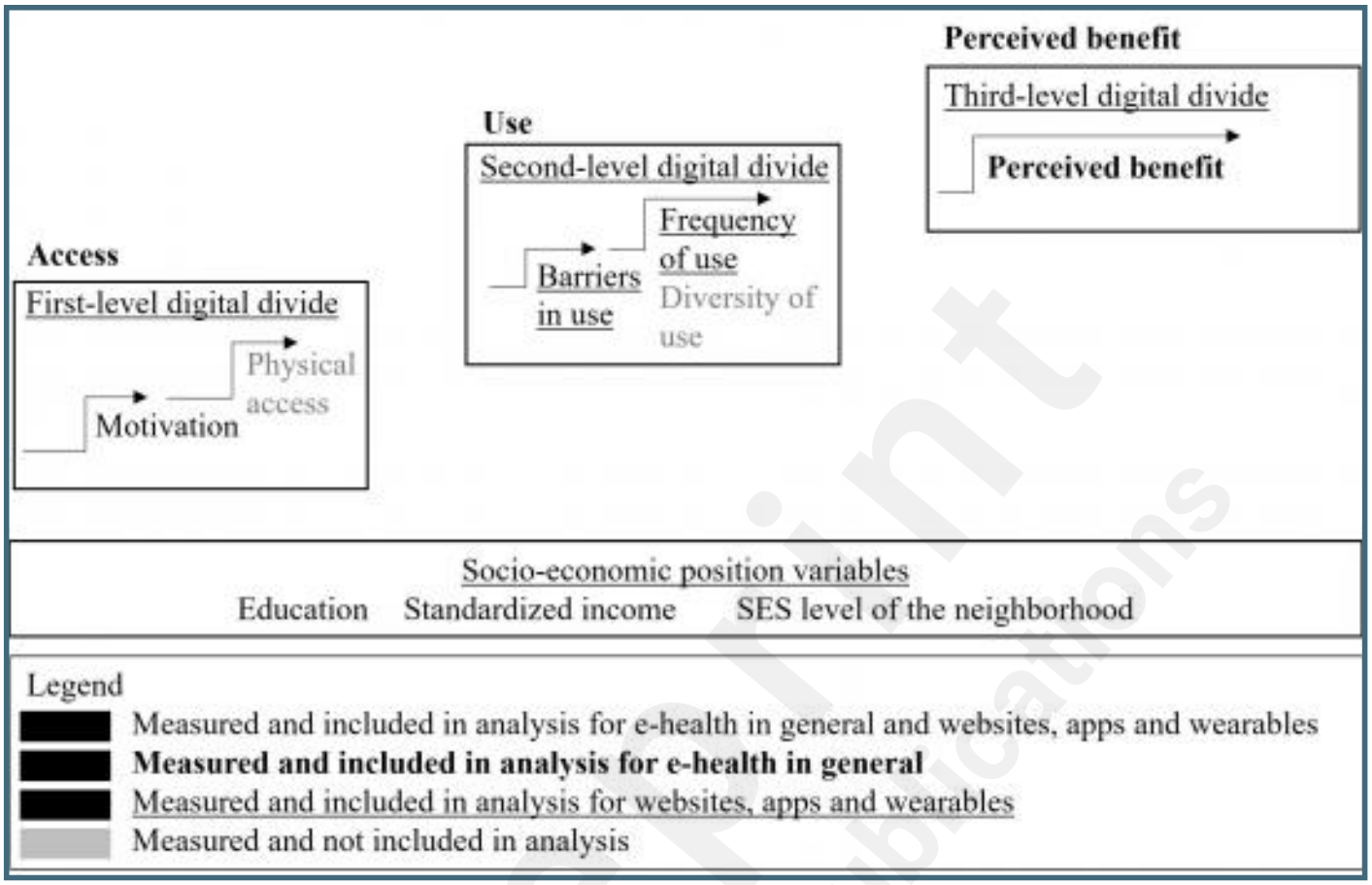
[k] The logistic regression and ordered logistic regression analyses are corrected with age as a covariate.

[l] * p<0.05, ** p<0.01, *** p<0.001

	(comparison population low)		(1.19 - 2.55) **		(0.77 - 1.54)		(0.92 - 2.75)		(0.78 - 1.64)		(0.74 - 2.13)
	High (comparison population medium)		1.63 (1.1 - 2.43) *		1.23 (0.86 - 1.77)		1.23 (0.69 – 2.18)		1.12 (0.76 - 1.65)		1.11 (0.64 - 1.93)

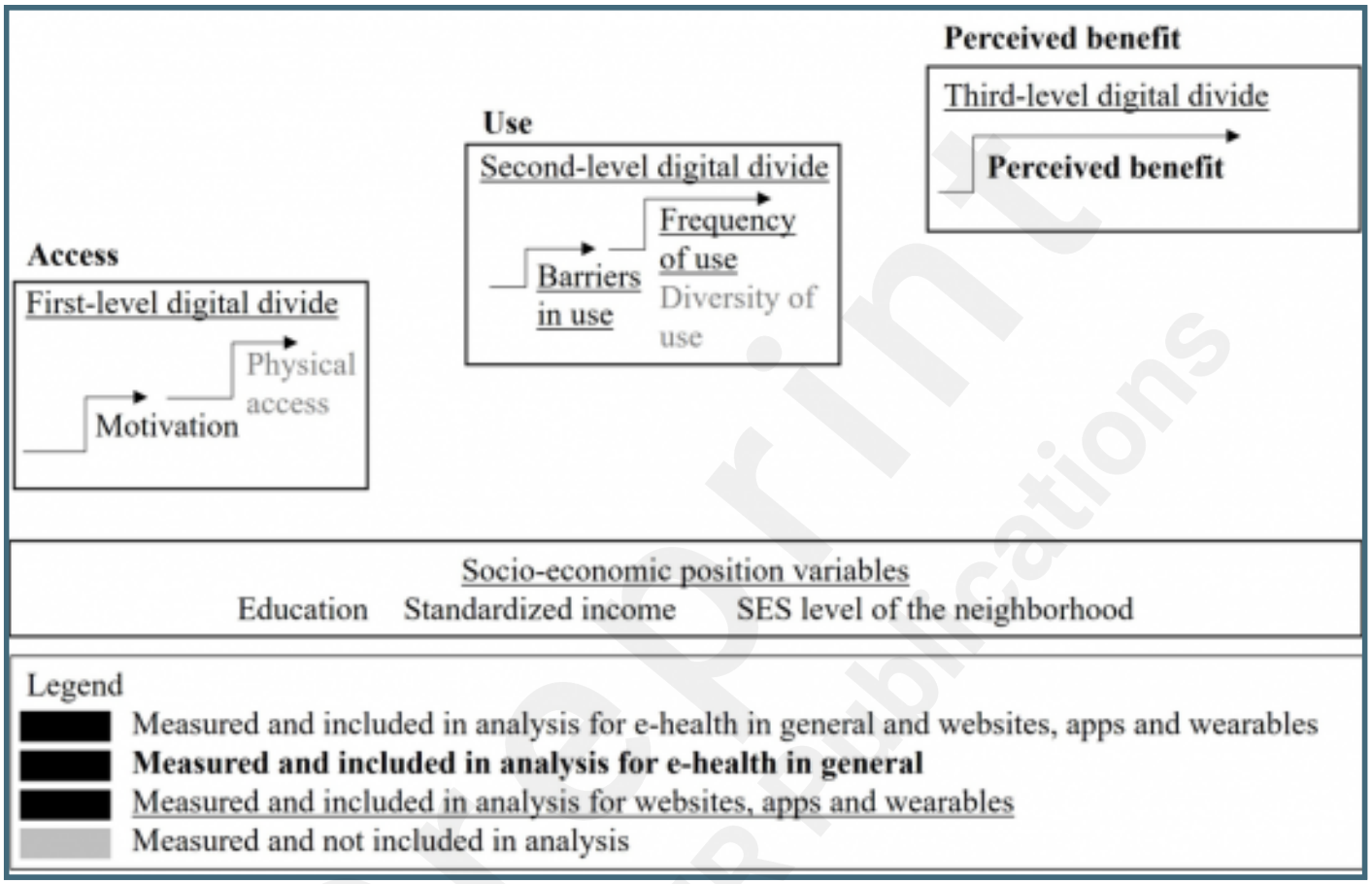
Supplementary Files

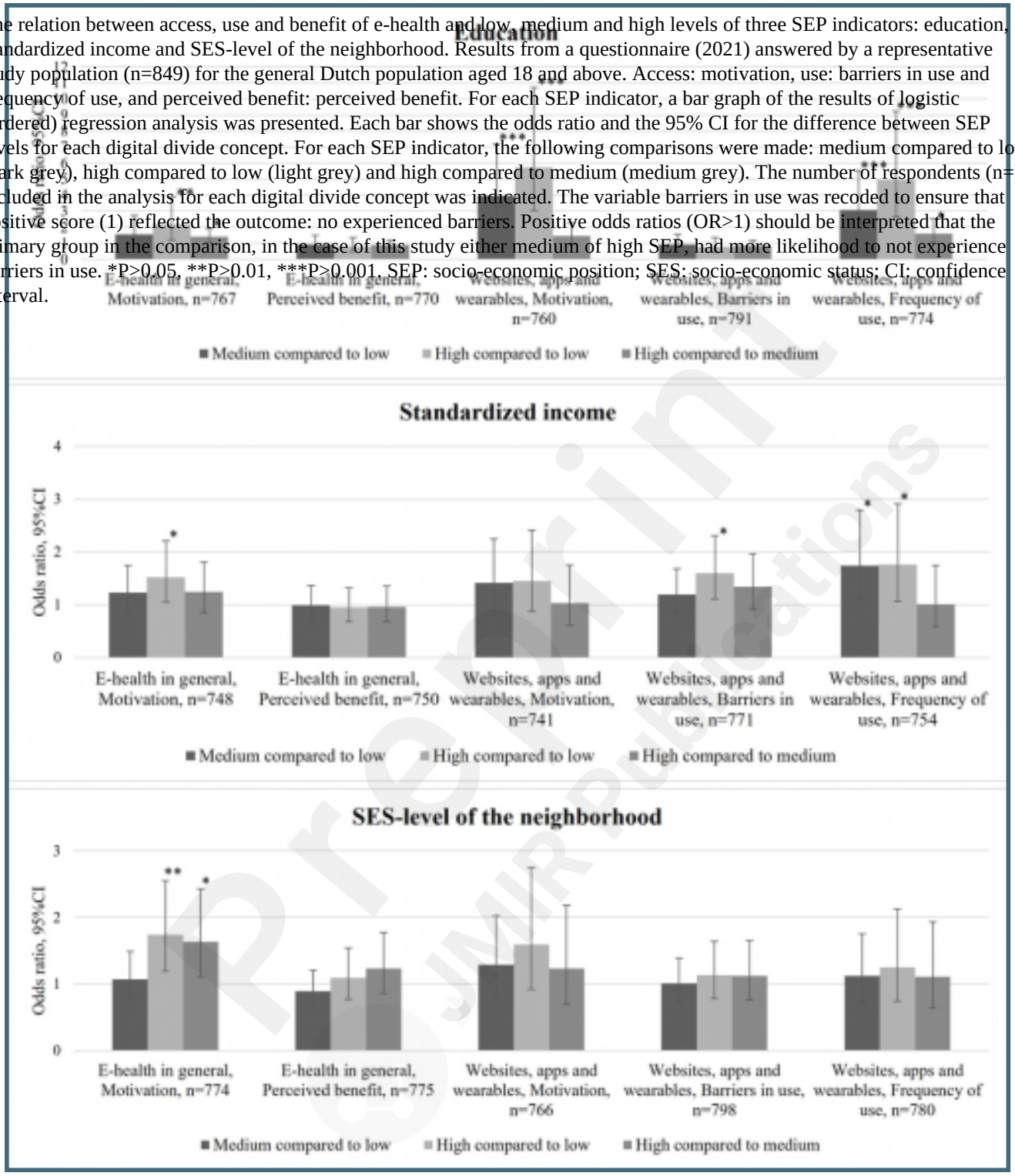
Untitled.



Figures

Overview of the concepts access, use and perceived benefit, the variables matched to these concepts and the socio-economic position indicators used in this study. Legend indicates whether the variables were matched for e-health in general (bold), websites apps and wearables (underlined) or both. Secondly, the legend indicates whether the variables were viable, either included (black) or not included (grey), for logistic (ordered) regression analysis. Adapted from Jan van Dijk (2020), The Digital Divide p.64 [57]. SES: socio-economic status.





The relation between access, use and benefit of e-health and low, medium and high levels of three SEP indicators: education, standardized income and SES-level of the neighborhood. Results from a questionnaire (2021) answered by a representative study population (n=849) for the general Dutch population aged 18 and above. Access: motivation, use: barriers in use and frequency of use, and perceived benefit: perceived benefit. For each SEP indicator, a bar graph of the results of logistic (ordered) regression analysis was presented. Each bar shows the odds ratio and the 95% CI for the difference between SEP levels for each digital divide concept. For each SEP indicator, the following comparisons were made: medium compared to low (dark grey), high compared to low (light grey) and high compared to medium (medium grey). The number of respondents (n=) included in the analysis for each digital divide concept was indicated. The variable barriers in use was recoded to ensure that positive score (1) reflected the outcome: no experienced barriers. Positive odds ratios (OR>1) should be interpreted that the primary group in the comparison, in the case of this study either medium of high SEP, had more likelihood to not experience barriers in use. *P>0.05, **P>0.01, ***P>0.001. SEP: socio-economic position; SES: socio-economic status; CI: confidence interval.