Digital Health Literacy and Sport-Physical Activities: The Moderating Role of Age

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Abstract

Background : The present study extends understanding of digital health literacy by exploring issues that clarify how and when sport-physical activities enhance digital health literacy measured by four types of health-related information searched on the Internet i.e., general health information, information on a specific injury or condition, specific information on a medical treatment or procedure and information regarding second opinion after visiting a doctor.

Methods: We employ Tobit model on the large European data (N=5,318). **Results:** We find support for direct relation between sport-physical activities and digital health literacy. In addition, we find that the effect of sport-physical activities on digital health literacy is reversed when interacted with age.

Conclusion: This evidence is consistent with the view that sport-physical activities can be considered as an important tool for digital health literacy improvement but only under certain socio-demographic characteristics.

Background

Internet technologies are considered as major developments in the last twenty years that affect all sectors around the globe as well as healthcare sector. Actually, as concluded in [1], Internet is recognised as primary mechanism for health-related information dissemination. Therefore, Internet has become an imperative in every attempt to improve healthcare [2]. Scholars [3], [4] identified the benefits of Internet for healthcare sector such as instant access to a vast array of information, improved communication between patients and doctors, and support for interpersonal interactions and social support. However, there are a number of constraints to be fulfilled, in order to contribute to better utilisation of Internet for healthcare purpose.

One of the main factors that determine the benefits of Internet usage for healthcare outcomes is associated to digital health literacy [5]. Digital health literacy is defined as degree to which individuals have the capability to obtain, process, and understand basic health information and services needed to make appropriate health decisions [5-7]. Furthermore, poor health literacy could drive to several adverse health outcomes, such as delayed diagnoses, poor adherence to treatment regimens, mortality, hospitalization and emergency care visits [8-9]. In the same vein, in [10], it is argued that comparing to individuals who have high health literacy, those with low health literacy have poorer health outcomes.

It is considered that poor health literacy is linked with unhealthy lifestyle behaviours such as poor diet, smoking and a lack of physical activity [11-14]. Actually, it is argued that sports activities establish a platform for learning various personal health-related skills that are not only related to motor skills [15-17]. In addition, previous scholars underline that health literacy is dependent on health behaviours such as sport-physical activity [7], [18-20].

However, in [21], it is indicated that there is limited data on the relation between health literacy and health promoting behaviours associated to sport-physical activity. Therefore, considering importance of sport- physical activities for digital health literacy, our first objective is to empirically examine this relationship. What more since little is known about the link of health literacy with health information-seeking type [22-23] this paper distinguishes between four digital health literacy indicators associated with different types of health-related information searched on the Internet i.e., general health information, information on a specific injury or condition, specific information on a medical treatment or procedure and information regarding second opinion after visiting doctor.

Moreover, one stream of literature specifically suggests that the digital health literacy is contingent upon socio-demographic characteristics [24-25]. As suggested in [7], investigating contingent factors associated to digital health literacy would also be of great importance because these might be objectives for further improvements. Technology acceptance suggests that individual demographics affect the embracement of new technologies [26-28]. Age is associated to demographic characteristics that represents experience (or lack of experience) with certain health issues [25], but also to the Internet utilisation. For instance, rates of poor health literacy are associated with older age, low income and low educational level [29-30]. Consequently, we build and test a model of the impact of sport-physical activity on digital health literacy by introducing a moderator factor, namely, age.

The main intended contribution of this study is therefore to develop a more detailed understanding of how and to what extent sport-physical activities enhance digital health literacy. Does age moderate relationship between sport- physical activities and digital health literacy? Answering these questions contributes to emerging research concerning the drivers that could help digital health literacy improvement. Actually, comparing to previous studies on the subject our analysis will include individuals from various age groups and

countries since in order to enhance health literacy at the population level, the analysis needs to cover sample across various age groups and settings [17].

To address these questions empirically, we rely on the *European citizens' digital health literacy* data which is conducted by TNS Political & Social at the request of the European Commission, Directorate-General Communication Networks, Content and Technology (DG CONNECT). Respondents from different social and demographic groups were interviewed via telephone in their mother tongue on behalf of the European Commission. Noteworthy, respondents from 28 EU countries are present in the sample, what makes important factors when considering generalisability of the findings. In addition, as argued in [19], [31], [32] research is still lacking regarding the analysis on overall populations, due employing *European citizens' digital health literacy* data will give us possibility to obtain more general understanding concerning the link between digital health literacy and sport-physical activities.

The rest of this article is organized into four sections. In the next section, we present previous literature leading up to our hypotheses for direct and moderating effects. In the two subsequent sections, we detail our method and obtained results. In the final section, we discuss the obtained findings and practical implications.

The relationship between health literacy and sport-physical activities

Previous scholars [17], [20], [33], [34] have recognised the link between health literacy and health behaviours. More precisely, health behaviour is related to physical activity, fruit and vegetable consumption, smoking behaviour, breakfast consumption, alcohol consumption, and body mass index (BMI), all of which are known to be linked to health status and health outcomes [17-20], [35], [36]. Among above mentioned indicators that are associated with health behaviours, in [7] and [20] is identified physical activity as the important pathway between health literacy and health outcomes. Accordingly, in [17] is stressed out that sport-physical activities are associated with better coping skills needed in daily life what includes also health literacy empowerment. Moreover, in [37] is proposed that health promotion action, such as physical activities, creates an intermediate set of health promotion outcomes, including health literacy, which in turn affects health outcomes.

Empirical work investigating the link between health literacy and sport-physical activities has mainly confirmed the positive relationship. For instance, conducting a cross-sectional study using data from the Rush Memory and Aging Project, which includes 556 older persons, in [21] is found that higher health literacy scores were associated with more frequent participation in health promoting behaviours, including cognitive, physical and social activities. In the same sense, using data from The Netherlands on older people, in [7] is found a negative association between inadequate health literacy and physical activity. In addition, in [20] is confirmed the findings on the sample of 3,241 participants, showing that low health literacy was associated with insufficient physical activity, insufficient fruit and vegetable consumption, lack of regular breakfast consumption, obesity and low alcohol use, but not with smoking. Furthermore, working on the population-based survey among colorectal cancer (CRC) survivors, in [38] is demonstrated that CRC survivors with low health literacy did not meet the prescribed physical activity guidelines compared with survivors with medium or high health literacy. Moreover, the authors indicate that CRC survivors with low health literacy reported statistically significantly lower levels of mental and physical health-related quality of life and higher distress levels compared with survivors with medium and high health literacy. Working on the data from Finland among school children, in [17] is shown that perceived health literacy was higher among adolescents who participated in sports club activities.

Based on previous discussion, we posit that:

H1. Sport-physical activities have a positive impact on digital health literacy.

The moderating effect

Both health literacy and sport-physical activities are considered to be contingent upon socio-demographic characteristics. Moreover, socio-economic and demographic factors such as age, income, education and health status determine people's probability to use the internet to seek health information [39-40]. Accordingly, in [40] is found that socio-demographic characteristics particularly age, education, income, perceived health and social isolation are associated with having access to the internet confirming that a 'digital divide' exists among various groups.

Considering that ageing populations presents fundamental European challenges, achieving enhancing health literacy level among different age groups is crucial. However, even that Internet offers the elderly population significant potential for remaining independent longer [41], the elderly lag behind in using and benefiting from information technology (IT) [42]. Accordingly, older adults are at a risk of low health literacy [32]. Moreover, rates of inadequate health literacy have been shown to be higher in adults with older age [14], [20], [43], [44]. The Canadian Council on Learning [45] even reported that health literacy decline begins in early adulthood and continues to fall into old age. The literature identified that the reason for not using IT among older adults are cognitive decline associated with aging processes and attitudes such as anxiety about computer use and the perception that the technology was not useful for them [46-47]. On other hand, younger population is considered to be more frequent health information seekers [25], [46], [48], [49].

Therefore, we present the following hypothesis:

H2. Age moderates negatively the relationship between sport-physical activities and digital health literacy.

1. Methods

Data and sample

This study relies on the Flash Eurobarometer report No. 404 "European citizens' digital health literacy" which aims to assess the extent to which Europeans already use the Internet and online resources to help manage their own health. The data provide information on the type of health-related information people most commonly look for, where they look for it and why they look for it, how likely they would be to use the Internet to look for health-related information in the future, level of Internet usage among Europeans, and also of the health of European citizens and other health-related issues (e.g. doctor visits, frequency of physical exercise).

The data used was carried out by TNS Political & Social network in the 28 Member States of the European Union during September 2014. Respondents from different social and demographic groups were interviewed. After eliminating observations with missing values that are relevant for this study, our final sample counts for 5,318 observations (the sample changes is related to the dependent variable utilisation).

Dependent Variable

As it was indicated previously, we distinguish between four types of health-related information searched on the Internet i.e., general health information, information on a specific injury or condition, specific information on a medical treatment or procedure and information regarding second opinion after visiting doctor. More precisely, the questions were defined as following: *On average, within the last 12 months, how often have you used the Internet to* (1) access general information on health-related topics or ways to improve health; (2) access on a specific injury, disease, illness or condition; (3) get a second opinion after having visited doctor; (4) find specific information on a medical treatment or procedure. The questions are designed on 5-point scale anchored by 1 = "few times within the past year", 2 = "approximately once every two months", 3 = "approximately once a month", 4 = "Several times a month", 5 = "once a week or more often".

Independent variable

Our main independent variable is related to sport-physical activities and it is measured using following question: *How often do you exercise or play sports? By ‘exercise’, I mean any form of physical activity which you do in a sports context or sports-related setting, such as swimming, training in a fitness centre or a sports club, running in the park etc.* The variable is also designed using 6-point scale with value 1= “never”, 2 = “less often”, 3 = “1 to 3 times a month”, 4= “1 to 2 times a week”, 5= “3 to 4 times a week”, 6= “5 times a week or more” .

Control Variable

Furthermore, we control for respondent specific characteristics that are found to determine health literacy by including additional control variables. Actually, following previous scholars [7], [20], [39], [40] we include following control variables: (1) gender; (2) age; (3) age when stopped full-time education; (4) occupation; (5) general health condition; (6) long-term disease or a health problem lasted at least 6 months; (7) frequency of doctor visits; (8) general knowledge of health-related topics; (9) types of information searched; (10) internet source used; (11) for whom respondent searched information.

Noteworthy, we interact our independent variable sport-physical activities with age to see if it moderates the sport-physical activities-health literacy link. In order to avoid multicollinearity between the interaction terms and their components, we follow the approach suggest in [51]. More precisely, we mean-center the direct terms by subtracting the mean of each variable from the values of each observation.

In Table 1 we present descriptive statistics of variables used.

Table 1 Sample statistics

Variable	N	Mean	Std. Dev	Min	Max
General information on health-related topics or ways to improve health	5318	2.79	1.49	1	5
Information on specific injury, disease, illness or condition	5108	2.29	1.41	1	5
Information to get a second opinion after having visited doctor	824	1.95	1.31	1	5
Information to find specific information on a medical treatment or procedure	2372	2.42	1.43	1	5
Sport-Physical Activities	5318	3.45	1.21	1	5
Age	5318	45.35	14.56	16	89
Gender	5318	0.38	0.49	0	1
Age when you stopped full-time education	5318	21.87	5.59	2	65
Self-employed	5318	0.11	0.31	0	1
Employee	5318	0.50	0.50	0	1
Manual worker	5318	0.08	0.27	0	1
Without a professional activity	5318	0.31	0.46	0	1
General health condition	5318	1.75	0.55	1	4
Long-term disease or a health problem lasted at least 6 months	5318	2.40	0.85	1	3
Frequency of doctor visits	5318	2.40	0.93	1	4
General knowledge of health-related topics	5318	1.99	0.51	1	4
Info on mental well-being, depression, stress	5318	0.24	0.43	0	1
Info on lifestyle choices	5318	0.71	0.45	0	1
Info on pregnancy, childbirth and early infancy	5318	0.12	0.33	0	1
Info on pharmaceuticals	5318	0.39	0.49	0	1
Info on caring for an ageing person	5318	0.12	0.33	0	1
Testimonials or experiences from other patients	5318	0.25	0.44	0	1
Info on healthcare professionals or healthcare centers	5318	0.29	0.45	0	1
Info on vaccinations	5318	0.14	0.34	0	1
Other types of info searched	5318	0.14	0.34	0	1
Internet search engines	5318	0.83	0.38	0	1
Online newspapers or magazines	5318	0.26	0.44	0	1
Specific and dedicated websites, blogs or forums	5318	0.40	0.49	0	1
Online social networks	5318	0.41	0.32	0	1
Patient organizations' websites	5318	0.12	0.32	0	1
Specific and dedicated apps for mobile devices such as tablets or mobile		0.14	0.34	0	1

phones

	5318				
Websites from official health organizations	5318	0.29	0.45	0	1
Other types of sources	5318	0.01	0.10	0	1
Searching info for yourself	5318	0.86	0.34	0	1
Searching info for spouse	5318	0.29	0.45	0	1
Searching info for child/children	5318	0.29	0.45	0	1
Searching info for family	5318	0.29	0.45	0	1
Searching info for friends	5318	0.12	0.33	0	1
Searching info for others	5318	0.02	0.14	0	1

Empirical Model

Since in this paper the dependent variables are censored with an upper limit of 1, the Tobit regression model is an adequate econometric technique for determining the relationship between digital health literacy and sport-physical activities. The Tobit model expresses the dependent variable in relation to latent variables:

$$Y^* = \beta_0 + x\beta + u, u | x \sim \text{Normal}(0, \sigma^2)$$

$$Y = \max(0, Y^*)$$

2. Results

Tables 2 and 3 report the estimation results of our empirical models, direct and moderating effect, respectively.

Model 1 presents the direct model where dependent variable represents general information on health-related topics or ways to improve health. We can observe that sport-physical activities have significant and positive effect on digital health literacy ($t = 0.12, p < 0.01$). The results are going in the same direction when looking Model 2 where dependent variable refers to the information on a specific injury, disease, illness or condition. More precisely, we can conclude that sport-physical activities improve respondents' digital health literacy ($t = 0.11, p < 0.01$). Furthermore, Model 3, reveals that sport-physical activities improve digital health literacy measured by information about opinion after having visited doctor ($t = 0.24, p < 0.01$). Finally, the results are also confirmed in the Model 4 where dependent variable is related to the specific information on a medical treatment or procedure ($t = 0.11, p < 0.01$). The obtained findings using all four indicators of digital health literacy support our H1. In addition, our results lend support to previous studies that show positive link between sport-physical activities and digital health literacy [7], [17], [20]. Accordingly, we may suggest that participation in sport-physical activities creates skills as well as environment that support digital literacy empowerment, including also health literacy.

Turning to the control variables, we can see that age, gender, profession, general health knowledge and internet search engines influence negatively digital health literacy. On the other hand, general health condition, frequency of doctor visits, types of information searched, specific internet source such as online newspapers or magazines, specific and dedicated websites, blogs or forums and online social networks could be considered as important drivers of digital health literacy improvement. Noteworthy, the findings also indicate that being self or surrogate seeker (who seeks health information for others) [52], also improve digital health literacy. However, the results are not confirmed when searching is oriented to children.]

Table 2
Results of Tobit model-direct effect

	Model 1		Model 2		Model 3		Model 4	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Sport-Physical Activities	.12***	.02	.11***	.03	.24***	.08	.11***	.04
Age	– .01***	.00	– .01***	.00	– .02*	.01	– .01***	.00
Gender	– .30***	.06	– .18***	.07	.06	.22	– .32***	.10
Age when you stopped full-time education	.01	.01	.01**	.01	.00	.02	.01	.01
Employee	– .01	.09	– .06	.12	– .24	.35	– .37***	.17
Manual worker	– .21*	.13	– .29*	.16	– .13	.51	– .13	.23
Without a professional activity	– .03	.10	.03	.13	.22	.37	– .22	.18
General health condition	.21***	.06	.32***	.07	.54***	.19	.31***	.09
Long-term disease or a health problem lasted at least 6 months	– .02	.04	– .10***	.04	.10	.13	.01	.06
Frequency of doctor visits	.12***	.03	.18***	.04	.18	.13	.13***	.06
General knowledge of health-related topics	– .44***	.06	– .39***	.07	– .49***	.22	– .41***	.09
Info on mental well-being, depression, stress	.33***	.07	-	-	-	-	-	-
Info on lifestyle choices	.46***	.06	-	-	-	-	-	-
Info on pregnancy, childbirth and early infancy	.47***	.09	-	-	-	-	-	-
Info on pharmaceuticals	.08	.06	-	-	-	-	-	-
Info on caring for an ageing person	.19***	.09	-	-	-	-	-	-
Testimonials or experiences from other patients	.07	.07	-	-	-	-	-	-
Info on healthcare professionals or healthcare centers	– .05	.07	-	-	-	-	-	-
Info on vaccinations	.01	.09	-	-	-	-	-	-
Internet search engines	– .28	.08	– .26***	.10	– .10	.27	– .37***	.13
Online newspapers or magazines	.22	.07	.40***	.09	– .04	.26	.57***	.12
Specific and dedicated websites, blogs or forums	.11	.06	.14*	.07	.27	.22	.26***	.10
Online social networks	.43	.07	.50***	.10	.86***	.25	.17	.13
Patient organizations' websites	.10	.09	.29***	.10	.21	.28	.38***	.13
Specific and dedicated apps for mobile devices such as tablets or mobile phones	– .01	.09	.03	.12	.07	.31	– .10	.16
Websites from official health organizations	– .22***	.07	.05	.08	– .07	.24		
Searching info for yourself	.14	.09	.05	.09	– .13	.28	.09	.12
Searching info for spouse	.16***	.07	.39***	.08	.39	.26	.10	.12
Searching info for child/children	.01	.07	.02	.08	.24	.25	.11	.12
Searching info for family members	.36***	.07	.45***	.08	.08	.25	.21*	.11
Searching info for friends	.22***	.088	.46***	.11	.08	.39	.39***	.16

	Model 1		Model 2		Model 3		Model 4	
Constant	1.82***	.30	1.17***	.35	– .74	1.07	1.86***	.49
Number of observations	5 318		5094		824		2372	
(*), (**) and (***) - indicate parameter significance at the 10, 5 and 1 per cent levels, respectively								

The moderator analysis is presented in Table 3. Model 1a indicates that age moderates negatively the relationship between sport-physical activities and digital health literacy ($t=-0.003$, $p < 0.01$). Furthermore, we can observe that positive effect of sport-physical activities on health literacy disappears in Model 2a when sport-physical activities are interacted with age. In other words, we obtain non-significant results. The similar situation is when looking Models 3a and 4a. Therefore, we can only partly support H2. Overall, the results from Table 3 are quite disappointing. Actually, despite all potential advantages of digital health literacy, the elderly is less likely to exploit them. What more, even that sport-physical activities could be considered as important mechanism for digital health literacy enhancement (as we can see from Table 2), it is not the case for older people. Actually, the positive effect of sport-physical activities is vanished by age. The obtained findings could be explained by two facts. Firstly, even that older people have more time to engage in healthy behaviours, they are less likely to be sufficiently physically active than younger adults [19]. Secondly, as discussed previously, older population shows significant resistance towards IT utilisation [46], [47].

Table 3
Results of Tobit model-moderating effect

	Model 1a		Model 2a		Model 3a		Model 4a	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Moderating Effect-Sport-Physical Activities* Age	– .003***	.00	.00	.02	.01	.01	– .0001	.003
Sport-Physical Activities	.12***	.024	.11***	.03	.24***	.08	.11***	.04
Age	.01	.01	– .02***	.01	– .03	.02	– .01	.01
Gender	– .32***	.06	– .17***	.07	.08	.23	– .32***	.10
Age when you stopped full-time education	.01	.01	.01***	.01	.00	.02	.01	.01
Employee	– .02	.09	– .07	.12	– .23	.35	– .38***	.17
Manual worker	– .22	.13	– .29*	.16	– .15	.51	– .13	.23
Without a professional activity	– .031	.10	.03	.13	.21	.37	– .21	.18
General health condition	.21***	.06	.32***	.07	.53***	.19	.31***	.09
Long-term disease or a health problem lasted at least 6 months	– .02	.04	– .10***	.04	.09	.13	.01	.06
Frequency of doctor visits	.11***	.03	.18***	.04	.18	.13	.13***	.06
General knowledge of health-related topics	– .45***	.06	– .39***	.07	– .49	.22	– .41***	.09
Info on mental well-being, depression, stress	.34***	.07	-	-	-	-	-	-
Info on lifestyle choices	.45***	.07	-	-	-	-	-	-
Info on pregnancy, childbirth and early infancy	.48***	.09	-	-	-	-	-	-
Info on pharmaceuticals	.09	.06	-	-	-	-	-	-
Info on caring for an ageing person	0.21***	.09	-	-	-	-	-	-
Testimonials or experiences from other patients	.07	.07	-	-	-	-	-	-
Info on healthcare professionals or healthcare centers	– .01	.07	-	-	-	-	-	-
Info on vaccinations	.03	.09	-	-	-	-	-	-
Internet search engines	– .28***	.08	– .26***	.10	– .11	.27	– .37***	.13
Online newspapers or magazines	.23***	.07	.40***	.10	– .03	.26	.57***	.12
Specific and dedicated websites, blogs or forums	.12**	.06	.14*	.07	.27	.22	.26***	.10
Online social networks	.41***	.07	.50***	.10	.86***	.25	.17	.13
Patient organizations' websites	.16*	.09	.28***	.10	.22	.28	.37***	.13
Specific and dedicated apps for mobile devices such as tablets or mobile phones	– .01	.09	.03	.12	.06	.31	– .10	.16
Websites from official health organizations	.22***	.07	0.05	.08	– .07	.24	.04	.11
Searching info for yourself	.08	.08	.052	.09	– .13	.28	.09	.12
Searching info for spouse	.15***	.068	.39***	.08	.40	.26	.10	.12
Searching info for child/children	0.01	.07	.02	.08	.24	.25	.11	.12

	Model 1a		Model 2a		Model 3a		Model 4a	
Searching info for family members	.35***	.06	.45***	.08	.08	.25	.21*	.11
Searching info for friends	.22***	.09	.46***	.11	.07	.39	.39***	.16
Constant	1.26***	.40	1.35***	.47	.08	1.45	1.72***	.65
Number of observations	5318		5094		824		2372	
(*), (**) and (***) - indicate parameter significance at the 10, 5 and 1 per cent levels, respectively								

Conclusion

In order to achieve objectives defined in "Health 2020" regarding enhancement of population health outcomes, promoting health literacy is considered as one of the crucial mechanism [53]. Moreover, in [54] is underlined that addressing the challenges related to low health literacy should be considered as an urgent priority. Previous scholars tried to identify mechanism that could help improvement of digital health literacy, and one of the proposed mechanisms is sport-physical activities [17], [20]. However, based on the existing literature, in [31] is concluded that health literacy and sport-physical activities are both known to be related to population health, however further investigation is needed to understand better their relation.

Therefore, in our study, we analysed the relation between sport-physical activities and digital health literacy measured by four indicators associated with types of health-related information searched on the Internet. In addition, we examine how the relation between sport-physical activities and digital health literacy may be moderated by age. Accordingly, a comprehensive model is presented here, aiming to shed some light on a complex real phenomenon where sport-physical activities, digital health literacy and age are interlinked. The results based on the large European data, show that sport-physical activities are positively correlated to digital health literacy. The results are confirmed for all four indicators of health literacy namely search on general health information, information on a specific injury or condition, specific information on a medical treatment or procedure and information regarding second opinion after visiting doctor.

Regarding the moderating effect, the significantly negative association between sport-physical activities and health literacy (associated to search on general health information) when moderated by age confirms our belief that older population shows important resistance regarding utilisation of IT, therefore, the positive effect of sport-physical activities could not hold when interact with age. In addition, the positive effect of sport-physical activities also disappears when interacted with age for three other indicators of digital health literacy. Therefore, our study highlights the importance of socio-demographic characteristics when analysing digital health literacy. Accordingly, in order to improve health literacy among elderly population specific tailored health literacy program should be established that targets only this category of population [32]. In addition, online health providers have to create different interfaces that are suitable for different demographic groups [55].

Overall, our study also implies that in order to identify the mechanisms that could improve digital health literacy, we need to focus on the moderating effects. In this vein, our findings add to the recent literature which focuses on better identifying the mechanisms through which digital health literacy could be improved.

This study focuses on one socio-demographic characteristic, that is, age. Thus, we acknowledge the limitation of excluding potential impact from other socio-demographic characteristics as potential mediators. Furthermore, future analysis should identify other mechanisms that could serve as tool for improving digital health literacy a part of sport-physical activities. In addition, the date used is cross-sectional, due it does not allow for the assessment of definitive causal relationships. Longitudinal data would prove useful in establishing cause-and-effect relationships.

Declarations

Abbreviations

Not applicable.

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For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "All authors have read and agree to the published version of the manuscript. Conceptualization, I.M. and J.Š.J.; methodology, S.P.; software, S.P.; validation, I.M., J.Š.J. and S.P.; formal analysis, S.P. and I.M.; investigation, I.M. and J.Š.J.; resources, S.P.; data curation, S.P. and J.Š.J.; writing—original draft preparation, I.M. and J.S.J; writing—review and editing, S.P. and J.Š.J. and I.M.; visualization, J.Š.J; supervision, I.M, S.P and J.Š.J.; project administration, S.P.; funding acquisition, J.Š.J.

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References

1. Cline RJ, Haynes KM (2001) Consumer Health Information Seeking on the Internet: The State of the Art. *Health Education Research* 16: 671-692.
2. Martínez-Carao E, Cegarra-Navarro JG, García-Pérez A, Faidt M (2018) Healthcare service evolution towards the Internet of Things: An end-user perspective. *Technological Forecasting & Social Change* 136: 268-276.
3. Rice R (2006) Influences, usage, and outcomes of Internet health information searching: multivariate results from the Pew surveys. *International Journal of Medical Informatics* 75: 8-28.
4. Taha J, Sharit J, Czaja S (2009) Use of and satisfaction with sources of health information among older internet users and nonusers. *The Gerontologist* 49:663–673.
5. Pohl AL, Trill R (2016) Digital Health Literacy as Precondition for Sustainable and Equal Health Care – A Study Focusing the Users' Perspective. In 6th International Conference on Well-Being in the Information Society Springer 4: 37-46.
6. Ratzan SC, Parker RM (2000) Introduction. In: National Library of Medicine Current Bibliographies in Medicine: Health Literacy. Selden CR, editor; Zorn M, editor; Ratzan SC, editor; Parker RM, editor MD: National Institutes of Health, U.S. Department of Health and Human Service.
7. Geboers B, de Winter AF, Luten KA, Jansen CJM, Reijneveld SA (2014) The association of health literacy with physical activity and nutritional behaviour in older adults, and its social cognitive mediators. *Journal of Health Communication* 19:61–76.
8. Paasche-Orlow M, Wolf M (2007) The Causal Pathways Linking Health Literacy to Health Outcomes. *American journal of health behaviour* 1:19-26.
9. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K (2011) Low health literacy and health outcomes: an updated systematic review. *Annals of Internal Medicine* 155:97-107.
10. Herndon JB, Chaney M, Carden D (2011) Health literacy and emergency department outcomes: A systematic review. *Annals of Emergency Medicine* 57(4): 334–345.
11. UCL Institute of Health Equity (2015) Improving health literacy to reduce health inequalities. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/460710/4b_Health_Literacy-Briefing.pdf. Accessed 18 August 2019.
12. Morrisroe J (2014) Literacy Changes Lives 2014: A new perspective on health, employment and crime. file:///C:/Users/Dell/Downloads/2014_09_01_free_research_-_literacy_changes_lives_2014.pdf_RJZEXmT.pdf. Accessed 08 September 2019.
13. Adams RJ, Piantadosi C, Ettridge K, Miller C, Wilson C, Tucker G, Hill CL (2013) Functional health literacy mediates the relationship between socio-economic status, perceptions and lifestyle behaviours related to cancer risk in an Australian population. *Patient Education and Counselling* 91:206–212.
14. Wolf MS, Williams MV, Parker RM, Parikh NS, Nowlan AW, Baker DW (2007) Patients' shame and attitudes toward discussing the results of literacy screening. *Journal of Health Communication* 12:721–732.
15. Kokko S (2010) Health Promoting Sports Club – Youth sports clubs' health promotion profiles, guidance, and associated coaching practice in Finland. Academic Dissertation, University of Jyväskylä, Jyväskylä.
16. Geidne S, Quennerstedt M, Eriksson C (2013) The youth sports club as a health-promoting setting: An integrative review of research. *Scandinavian Journal of Public Health* 41:269–283.
17. Paakkari L, Kokko S, Villberg J (2017) Health literacy and participation in sports club activities among adolescents. *Scandinavian Journal of Public Health* 45:854-860.
18. Huang CJ, Hu HT, Fan YC, Liao YM Tsai PS (2010) Associations of breakfast skipping with obesity and health-related quality of life: evidence from a national survey in Taiwan. *International Journal of Obesity* 34:720–725.
19. Södergren M, McNaughton SA, Salmon J, Ball K, Crawford DA (2012) Associations between fruit and vegetable intake, leisure-time physical activity, sitting time and self-rated health among older adults: cross-sectional data from the WELL study. *BMC Public Health* 12:551-600.
20. Geboers B, de Winter AF, Spoorenberg SL, Wynia K, Reijneveld SA (2016) The association between health literacy and self-management abilities in adults aged 75 and older, and its moderators. *Quality of Life Research* 25:2869-2877.

21. Bennett JS, Boyle PA, James BD, Bennett DA (2012) Correlates of health and financial literacy in older adults without dementia. *BMC Geriatrics* 12:30-39.
22. Lambert SD, Loiselle CG (2007) Health Information-Seeking Behavior. *Qualitative Health Research* 17:1006-1025.
23. Kim SH, Utz S (2018) Association of health literacy with health information-seeking preference in older people: A correlational, descriptive study. *Nurse Health Science* 20:355–360.
24. Venkatesh V, Morris MG, Davis GB Davis FD (2003) User acceptance of information technology: Toward a unified view. *MIS Quarterly* 27:425-478.
25. Sheng X, Simpson PM (2015) Health care information seeking and seniors: Determinants of internet use. *Health Marketing Quarterly* 32:96–112.
26. Im S, Bayus BL, Mason CH (2003) An empirical study of innate consumer innovativeness, personal characteristics, and new-product adoption behaviour. *Journal of the Academy of Marketing Science* 31:61-73.
27. Meuter ML, Bitner MJ, Ostrom AL, Brown SW (2005) Choosing Among Alternative Service Delivery Modes: An Investigation of Customer Trial of Self-Service Technologies. *Journal of Marketing* 69:61-83.
28. Parasuraman AP (2000) Technology Readiness Index (Tri): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. *Journal of Service Research* 2:307-320.
29. Scott TL, Gazmararian JA, Williams MV, Baker DW (2002) Health literacy and preventive health care use among Medicare enrollees in a managed care organization. *Medical Care* 40:395–404.
30. Kutner M, Greenberg E, Jin Y, Paulsen C, White S (2006) The health literacy of America's adults: Results from the 2003 National Assessment of Adult Literacy. <https://nces.ed.gov/pubs2006/2006483.pdf>. Accessed 20 August 2019.
31. Riecken KHB (2004) Reading Into Physical Activity: Exploring Relationships Between Health Literacy and Physical Activity In The Community, Dissertation, University of Victoria.
32. Chen MF, Lin NP (2018) Incorporation of health consciousness into the technology readiness and acceptance model to predict app download and usage intentions. *Internet Research* 28:351-373.
33. Mitsutake S, Shibata A, Ishii K, Oka K (2012) Association of eHealth literacy with colorectal cancer knowledge and screening practice among internet users in Japan. *Journal of medical Internet research*, 14:153.
34. Hsu WC, Chiang CH, Yang SC (2014) The Effect of Individual Factors on Health Behaviors Among College Students: The Mediating Effects of eHealth Literacy. *Journal of medical Internet research* 16: 287.
35. Blow FC, Walton MA, Barry KL, Coyne JC, Mudd SA, Copeland LA (2000) The relationship between alcohol problems and health functioning of older adults in primary care settings. *Journal of the American Geriatrics Society* 48:769–774.
36. Kaplan MS, Huguet N, Feeny D, McFarland BH, Caetano R, Bernier J, Ross N (2012) Alcohol use patterns and trajectories of health-related quality of life in middle-aged and older adults: A 14-year population-based study. *Journal of Studies on Alcohol and Drugs* 73:581–590.
37. Nutbeam D (2000) Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International* 15: 259–267.
38. Husson O, Mols F, Fransen MP, van de Poll-Franse LV Ezendam NPM (2015) Low subjective health literacy is associated with adverse health behaviors and worse health-related quality of life among colorectal cancer survivors: Results from the profiles registry. *Psycho-Oncology* 24:478–486.
39. Kontos EZ, Emmons KM, Puleo E, Viswanath K (2010) Communication inequalities and public health implications of adult social networking site use in the United States. *Journal of Health Communication* 15:216-235.
40. Estacio EV, Whittle R, Protheroe J (2019) The digital divide: Examining socio-demographic factors associated with health literacy, access and use of internet to seek health information. *Journal of Health Psychology* 24: 1668-1675.
41. Czaja S, Lee CC (2007) The impact of aging on access to technology. *Universal Access in the Information Society* 5:341- 349.
42. Björn N, Plattfaut R (2013) Internet adoption by the elderly: Employing IS technology acceptance theories for understanding the age-related digital divide, *European Journal of Information Systems* 23:708-726.
43. von Wagner C, Knight K, Steptoe A, Wardle J (2007) Functional health literacy and health-promoting behaviour in a national sample of British adults. *Journal Epidemiology and Community Health* 61:1086-90.

44. Olives T, Patel R, Patel S, Hottinger J, Miner J R (2011) Health literacy of adults presenting to an urban ED. *The American Journal of Emergency Medicine* 29:875–882.
45. Canadian Council on Learning (2007) *Health Literacy in Canada: Initial Results from the International Adult Literacy and Skills Survey*. Ottawa ON.
46. Werner JM, Carlson M, Jordan-Marsh M, Clark F (2011) Predictors of computer use in community-dwelling, ethnically diverse older adults. *Human Factors* 53:431–447.
47. Slegers K, van Boxtel MPJ, Jolles J (2012) Computer use in older adults: determinants and the relationship with cognitive change over a 6-year episode. *Computers in Human Behaviour* 28:1–10.
48. Lorence D, Park H, Fox S (2006) Assessing health consumerism on the web: a demographic profile for information-seeking behaviours. *Journal of Medical System* 30:251–8.
49. Lorence D, Park H (2006) Web-based consumer health information: public access, digital division, and remainders. *Med Gen Med*.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1785207/>. Accessed 18 August 2019.

50. Rains SA (2008) Health at high speed: Broadband internet access, health communication, and the digital divide. *Communication Research* 35: 283-297
51. Aiken LS, West SG (1991) *Multiple regression: Testing and interpreting interactions*. Thousand Oaks. Sage Publications. US.
52. Sadasivam RS, Kinney RL, Lemon SC, Shimada SL, Allison JJ, Houston TK (2013) Internet health information seeking is a team sport: analysis of the Pew Internet Survey. *International Journal of Medical Informatics* 82:193-200.
53. Sørensen K, Pelikan JM, Röthlin F, Kristin Ganahl, Slonska Z, Doyle G, Fullam J, Kondilis B, Agraftotis D, Ueters E, Falcon M, Mensing M, Tchamov K, van den Broucke S, Brand H (2015) Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). *Eur J Public Health*, 25:1053–1058.
54. Greenhalgh T (2015) Health literacy: towards system level solutions. *The BMJ* <https://doi.org/10.1136/bmj.h1026>
55. Hong QN, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M, Dagenais P, Gagnon MP, Griffiths F, Nicolau B, O’cathain A, Rousseau MC, Vedel I (2018) Mixed methods appraisal tool (MMAT).

http://mixedmethodsappraisaltoolpublic.pbworks.com/w/file/attach/127916259/MMAT_2018_criteria-manual_2018-08-01_ENG.pdf. Accessed 22 August 2019.