

Association of health and nutritional literacy with sun exposure in adults using structural equation modelling

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Abstract

Background: Inadequate health and nutritional literacy is a common problem among adults which is associated with poor health outcomes. Therefore, this study aimed to investigate the relationship between health and nutritional literacy to sun exposure behavior.

Methods: We conducted a cross-sectional study on 261 adults (18-65 years) in Iran. Knowledge, motivation, health literacy, nutritional literacy and sun exposure behavior using an interview-assisted questionnaire was evaluated. Using the information–motivation–behavioral skills model and structural equation modeling, we tested whether health and nutritional literacy was associated with the complex relationships among knowledge of vitamin D, attitudes toward sun exposure and sun exposure behavior. Beta and p values were calculated.

Results: Health literacy ($\beta = 0.29$, $p < 0.001$) and nutritional literacy ($\beta = 0.14$, $p = 0.02$) was directly associated with sunlight exposure. Indirect relationships also existed between knowledge and sunlight exposure through health literacy ($\beta = 0.33$, $p < 0.001$) and nutritional literacy ($\beta = 0.22$, $p = 0.01$). The model had good fit ($\chi^2/df = 1.422$; RMSEA = 0.040; CFI = 0.851; NFI = 0.657). There were no significant relationship between health literacy and motivation ($\beta = 0.11$, $p = 0.16$), nutritional literacy and motivation ($\beta = 0.06$, $p = 0.42$) and motivation and sun exposure ($\beta = 0.01$, $p = 0.91$).

Conclusions: Our findings showed that individuals with sufficient health and nutritional literacy more likely to have exposure to sunlight. Health and nutritional literacy should be considered when educating adults about vitamin D supplements and sunlight exposure.

Background

In the recent decades, numerous researches have reported the prevalence of vitamin D deficiency worldwide [1-3]. Vitamin D deficiency is a widespread health problem in all countries of all ages and in both sexes [4]. The prevalence of vitamin D deficiency in Iran is above 85% [5]. Vitamin D is a fat soluble vitamin, and is an essential nutrient for the body [6], which plays an important role in the health and survival of humans [7]. Several studies have focused on its role in the prevention of diseases such as heart disease [8], inflammatory bowel disease [9], multiple sclerosis [10], rheumatoid arthritis [11], Immune system diseases [12], diabetes [13] and infectious diseases [14]. Vitamin D deficiency around the world is probably due to limited sun exposure and insufficient intake of vitamin D from the diet [15]. It is well known that compared to usual diet, higher levels of vitamin D can be achieved through sun exposure [16]. Exposure to sunlight for 15–30 min raises serum vitamin D. Therefore, the production of vitamin D in the expose of ultraviolet rays of the sun (280-315 nm) in the human skin is the main source of supply for humans and parts of the body should be exposed to sunlight appropriately so that cholesterol changes to vitamin D [17]. This exposure to sunlight seems to provide enough vitamin D even in the winter, except for those who cannot or do not want to go out of the house. Although many people may have heard about vitamin D, they are unaware of its major role and resources. Knowledge about

vitamin D and the motivation to sunlight is relatively limited in many societies [18]. Inadequate knowledge, motivation to sunlight can reduce the exposure to sunlight and thus reduce vitamin D intake. In some studies, knowledge and motivation have been considered as effective factors in promoting health behaviors as well as the development of health and nutritional literacy [19]. Many studies have also suggested that health and nutritional literacy affect knowledge and motivation, which affects health outcomes [20, 21].

Nutritional literacy is a skill and the ability to access, understand and understand information about healthy nutrition and use them to have a healthy diet and lifestyle [22]. Previous studies have shown that nutritional literacy is significantly associated with health behaviors among adults [23]. The results of the studies show that increasing knowledge and nutritional literacy has a significant effect on changing the diet of people towards a healthy diet and a suitable nutritional model [24].

Health literacy is a personal and social capacity for access to understanding, assessment, information and health services, and optimal utilization of it for the promotion and improvement of health [25]. Based on research, poor health literacy is also associated with poorer health status [26], poor less use of flu vaccination [27] and higher BMI. Health literacy has now been highlighted in many countries as a global problem.

Health and nutritional literacy may play a role in the complex relationship among knowledge, motivation and sun exposure behavior. Since there has not been a study that investigated on relationship between health and nutritional literacy on sunlight exposure and in addition limited studies focused on health and nutrition literacy, so the present cross-sectional study aimed to investigate the relationship between health and nutrition literacy on sunlight exposure using Structural Equation Modelling (SEM) [28].

Subjects And Methods

Study design and participants This cross-sectional study was carried out from February to July 2018. Two hundred and sixty one Iranians adults (18 to 65 years) referred to health centers in Tehran with the following inclusion criteria: adult men and women aged 18 to 65 years having at least reading and writing skills were included in the study. Participants were selected using two-stage cluster sampling of 25 health centers in Tehran. Health centers in Tehran were divided into five regions: North, South, East, West and Central and then prepared a list of health centers in each area, and 25 health centers were selected randomly based on the number of health centers in each region proration. Then, the total number of samples (261) divided by the number of health centers (25) and obtained the number of samples in each home centers. At least 261 subjects would be needed for analysis. This sample size for SEM analysis seems to be enough because the minimum sample size should not be lower than 200 [29]. Our study has been performed in accordance with the Declaration of Helsinki and has been approved by the ethical committee of Tehran University of Medical Sciences (IR.TUMS.VCR.REC.1396.4028) and informed consent was obtained from all participants. Participants were informed in detail about the study purpose before completing their written informed consent. The majority of participants were female (n = 166, male

= 95, missing = none) and mean age was 38.83 years (SD = 11.09). Eight tools were developed to collect data for this study. All survey instruments were read aloud and answers were recorded by the data collectors. The survey took 90 to 120 minutes to complete.

Demographic data

Demographic questionnaire included information on age, sex, education level, marital status, occupation, living status, smoking status, and number of illnesses. Gender was reported across two categories (1= male and 2= female), and age was reported on a continuous scale. Education level was reported across three categories (1= Intermediate, 2= diploma and 3= academic)

Health literacy

We used Health Literacy for Iranian Adult (HELIA) for data collection which is valid and reliable[30]. The questionnaire has 33 items in 5 options and measures 5 dimensions of urban health in Iran. The dimensions of this questionnaire include reading (4 questions), access (6 questions), comprehension (7 questions), assessment (4 questions) and decision making and behavior (12 questions). Scores are classified and interpreted as follows: 0–50, inadequate health literacy and 51-100, adequate health literacy.

Nutritional literacy

The Nutrition Literacy Scale (NLS) consisted of 28 items [31]. In general, items within each content area are ordered from the easiest to the more difficult. Scores are classified and interpreted as follows: 0–15, inadequate nutritional literacy and 16-28, adequate nutritional literacy.

Attitude toward sunlight exposure

Sunlight exposure was measured using six items: (1) "I like sunlight"; (2) "I use sunhat when exposed to sunlight"; and (3) "I use sunscreen products containing SPF \geq 15 when exposed to sunlight" (4) "I like outdoor activities" (5) "Usually I spend most of my time outdoors"(6) "The time I expose myself to sunlight is enough". Responses were measured for each question on a two options was given: 1 = agree and 2 = disagree. Items assessing attitude toward sun exposure were extracted from the literature [32].

Knowledge of vitamin D

For vitamin D knowledge, scores were calculated based on previous study by Boland et.al [33]. Knowledge of vitamin D was measured by five items: (1) "I have ever heard about vitamin D"; (2) "Vitamin D is good for bone health"; (3) "Vitamin D supports calcium absorption"; (4) "Vitamin D can be supplemented by sunlight exposure"; (5) "The minimum time needed for sunlight exposure is 30 min if we want our body to develop a sufficient amount of vitamin D". Responses were measured for each question on a two options was given: 1 = agree and 2 = disagree. Items assessing knowledge of vitamin D were extracted from the literature [32].

Sunlight exposure behavior

Sun exposure duration was used to calculate the hours of daily sun exposure over the previous week [34]. There were three choices for the amount of time spent outdoors each day ($0 \leq 5$ min, 1 = 5–30 min, and 2 ≥ 30 min) and four choices for clothing or skin exposure while outdoors (1 = face and hands only; 2 = face, hands and arms; 3 = face, hands and legs; and 4 = “face, hands, legs and arms”). A score to estimate of their weekly sun exposure was calculated. The amount of time spent outdoors and the amount of skin exposed was calculated for each day to create a daily sun exposure score. All seven days' sun exposure scores were summed to obtain the weekly sun exposure score. Scores are classified and interpreted as follows: ≥ 30 representing sufficient sunlight exposure and < 30 representing insufficient sunlight exposure.

Anthropometric measures

Weight was measured with light clothing and without shoes using a digital scale (Seca 808) and recorded to the nearest 100 g. The height was measured in a standing position without shoes, using the standard Seca stadiometer recorded with an accuracy of 0.1 cm. BMI was calculated as weight (kg)/[height (m)]². Waist and hip circumference was measured in a standing position at the level of the umbilicus. Blood pressure (BP) was measured two times with a calibrated sphygmomanometer after the subject in a seated position for 10 min. The mean of two measurements was recorded to be the subject's blood pressure.

Physical activity

Levels of physical activity were assessed with the IPAQ, a validated. Data from the IPAQ were used to estimate compliance with guidelines for physical activity, that is presented as (MET-h per week), categories 1 (Low), 2 (Moderate), and 3 (High) levels of activity [24].

Data analysis

Data were analysed using R version 3.4.4. A model was developed to study the hypothesized relationships among health literacy, nutritional literacy, knowledge of vitamin D, attitudes toward sunlight and sunlight exposure behavior. The model included latent variables including knowledge of vitamin D (indicated by five questions), attitudes toward sunlight exposure (indicated by six questions) and observed variables including health literacy, nutritional literacy and sunlight exposure behavior. The model's goodness of fit was determined using four measures of fit: relative chi-square (χ^2/df), normed fit index (NFI), comparative fit index (CFI) and root-mean-squared error associated (RMSEA). Smaller (χ^2/df) values indicate better fit and an insignificant (χ^2/df) is desirable. (χ^2/df) is thought to be less dependent on sample size, and values greater than 1 and below 2 are considered good fit [35]. NFI and CFI range from 0 to 1, with values closer to 1 representing very good fit [36]. RMSEA is an index of the degree to which a confirmatory structure approximates the data being modelled and a value less than 0.08 reflects good model fit [37]. A *P*-value of < 0.05 was considered statistically significant.

Results

Participant characteristics

In total, a convenient sample of 261 individuals participated in the study. The majority of participants were female (63.6%), overweight (42.1%), married (73.2%), Employed (51.7%), and had a higher education qualification (49.4%). The Participants' characteristics are summarised in **Table 1**.

Vitamin D Knowledge

This study has indicated a high level of vitamin D Knowledge. 83.9% of participants had heard about vitamin D, 83.1% of surveyed population were agreed on that vitamin D is good for bone health and 72.4% knew that vitamin D is necessary for supporting calcium absorption. 69% participants knew that vitamin D could be supplemented by sunlight exposure. Moreover, 64% of them had information on the minimum time needed to spend outdoors to get enough Vitamin D (**Table 2**).

Attitude toward sunlight exposure

The level of attitude toward sunlight exposure was relatively low. Almost half (55.2%) responded that they like sunlight. 64.4% of participants used sunscreen products with sun-protection factor (SPF) ≥ 15 and 80.0% used a parasol to shade themselves from the sun. 67.8% reported that like outdoor activities and 21.1% reported that spend most of time outdoors. Overall, 31.8 % of the participants feel that have had sufficient sunlight exposure (**Table 2**).

Sun exposure behavior, Health literacy and Nutritional literacy

68.25% of participants spent 30 and more than 30 minutes outdoors on last weekend. In this study, the majority of adults (81.2%, n= 212) had adequate level of health literacy (**Table 2**).

Regarding cut of point of the nutritional literacy, 37.9% of the participants had adequate level of nutritional literacy.

Relationships among knowledge, attitude and behavior (first model)

The first model describes the relationship among knowledge, attitude and behavior in direct path. The model fit values (CMIN/df = 1.719, NFI= 0.561, CFI= 0.734 and RMSEA= 0.053), suggest the model has an acceptable predictive ability or fit. The relationships between knowledge and sunlight exposure behavior were not significant ($\beta= 0.05$, $P=0.555$). In addition, to attitude toward sun exposure was not directly associated with sunlight exposure behavior ($\beta= 0.05$, $p=0.472$) (**Table 3**).

Relationships among knowledge, attitude and behavior through of health literacy (second model)

The second model indicates the relationship between knowledge, attitude and behavior and the effect of health literacy on this relationship. The model fit indices (CMIN/df = 0.953, NFI= 0.777, CFI= 1.000 and

RMSEA= 0.000) indicating a relatively satisfactory model fit to data. The paths between health literacy and sunlight exposure ($\beta = 0.29, p < 0.001$) and knowledge and health literacy ($\beta = 0.34, p < 0.001$) were statistically significant. Thus, health literacy had a direct effect on sunlight exposure. In addition, results confirmed the expected indirect effect of knowledge on sunlight exposure through health literacy. The path between attitude and health literacy ($\beta = 0.10, p = 0.350$) was not statistically significant (**Table 3**).

Relationships among knowledge, attitude and behavior through of nutritional literacy (Third model)

The third model indicates the relationship between knowledge, attitude and behavior and the effect of nutritional literacy on this relationship as observed variable. For the indirect effect of knowledge, attitude and behavior through nutritional literacy the model fit values were at acceptable level (CMIN/df = 1.011, NFI= 0.743, CFI= 0.996 and RMSEA= 0.006). Our result showed the significant path direct between knowledge and nutritional literacy ($\beta = 0.21, P = 0.020$) and positive effect of nutritional literacy on sunlight exposure ($\beta = 0.16, P = 0.009$). This result revealed that the relation between knowledge and sunlight exposure may be nutritional literacy dependent. The path between attitudes and nutritional literacy ($\beta = 0.05, p = 0.409$) was not statistically significant (**Table 3**).

Relationships among knowledge, attitude and sun exposure behavior through of health and nutritional literacy (final model)

Final model shows the relationship between knowledge, attitude and sun exposure behavior and the effect of health and nutritional literacy on this relationship (**Figure 1**). Results of this analysis indicated that there is a relationship between knowledge and sun exposure behavior and health literacy (knowledge and health literacy: $\beta = 0.33, p < 0.001$ and health literacy and sun exposure: $\beta = 0.29, p < 0.001$) and knowledge and sun exposure behavior and nutritional literacy (knowledge and nutritional literacy: $\beta = 0.22, p = 0.013$ and nutritional literacy and sun exposure: $\beta = 0.14, p = 0.027$). Indeed, this result indicates that relation between knowledge and sun exposure may be health and nutritional literacy dependent. There was not a significant relationship between attitude and sun exposure even engaging health literacy (attitude and health literacy: $\beta = 0.11, p = 0.165$ and health literacy and sun exposure: $\beta = 0.29, p < 0.001$) and nutritional literacy (attitude and nutritional literacy: $\beta = 0.06, p = 0.429$ and nutritional literacy and sun exposure: $\beta = 0.14, p = 0.027$). The final model showed adequate goodness of fit (RMSEA= 0.040, CFI=0.85, NFI = 0.657, CMIN/df, = 1.422).

Discussion

To our knowledge, current cross-sectional study was the first study to investigate the relationship between health literacy, nutritional literacy, vitamin D knowledge, motivation toward sun exposure and sun exposure behavior among adults. Because sun exposure is influenced by various factors and its examination requires the consideration of multiple variables, structures and the study of the complex relationships between them. SEM can provide appropriate results in this study. SEM allowed this study to examine the complexity of the health and nutritional literacy as an influence on relationship between vitamin D knowledge, motivation toward sunlight and sun exposure behavior.

As one part of the SEM, this study showed that knowledge of vitamin D was associated with sun exposure via health literacy and nutritional literacy. In addition, we found that health literacy and nutritional literacy were positively associated with sun exposure behavior. In this context, improving health and nutritional literacy might be a productive way to increase the sun exposure behavior in adults. Despite the lack of enough vitamin D intake [38], there is evidence of knowledge of vitamin D, beliefs and attitudes towards sunlight in worldwide [39]. In our study, almost all participants heard about knowledge of vitamin D, which was in line with a study by Vu LH et al. [32] conducted in Chinese women. In contrast to our findings, studies in England [40] and Saudi Arabia [18] and Canada [33] have reported poor knowledge. The results of previous studies on health behaviors showed that health and nutritional literacy are important factors that lead to behavioral change. In fact, health and nutritional literacy engage in the relationship between knowledge and health-related behaviors [41]. In addition to a direct relationship between health behaviors, health and nutritional literacy have been involved in the indirect relationship between knowledge and behavior [19]. One of the most important of these studies, Leung et al., with a high sample size (648) in China that suggests a relationships among health literacy, knowledge, motivation, and behaviour [42]. Also, in some studies, there is no direct relationship between knowledge and sun exposure, which is in line with the results of our study [43]. In contrast to our findings, others found a direct relationship between the knowledge of vitamin D and exposure to sunlight [44].

Our results also revealed no significant association between motivation to sun exposure. Additionally, health and nutritional literacy did not influence the relationship between motivation and sun exposure. The results of this cross-sectional study showed that individuals' motivation was not as good as knowledge of vitamin D and was moderately low. Our study showed that less than half of the individual had a positive attitude to sun exposure. Similar to our study, others from China [32] and Vietnam [45] have reported a negative attitude to sunlight. In contrast, the results of some studies indicated that people had a positive attitude toward exposure to sunlight [18, 39]. The vitamin D status is also very different in European, Asian and Middle Eastern countries [46]. However, comparisons with other countries are difficult due to cultural differences in sun exposure. This difference was due to various causes, including diet, air pollution and limiting sun exposure. We evaluated the motivation for adult vitamin D in Tehran, but the reasons for sunlight avoidance were not investigated in this study. An explanation for negative attitude could be cultural factor that associated with sun exposure in the sample was a "cover-up" (common among Muslim women) tradition and prevents skin contact with UV-B radiation that essential for vitamin D production [47]. As well as knowing the harmful effects of sunlight (eg, aging skin, darkening of the skin and skin cancer), have a greater impact on the behavior of adults, especially women, in limiting for sun exposure behavior [48]. On the other hand, the use of sunscreens, sunglasses or sun hat is a factor in reducing sun exposure among adults [49].

This study had several strengths. First, the current study is the first study to examine the relationship between health literacy, nutritional literacy, knowledge, motivation and sun exposure adults using SEM. Second, since the study is based on a large sample size and participants from a variety of age, professional, and educational backgrounds, these results have a high degree of credibility and

universality. Third, the participant cooperation was completely voluntary and the interview was conducted.

However, we should also consider a few limitations. First, causality cannot be inferred by the cross-sectional nature of this study, and longitudinal and experimental approaches are needed to further explore the relationship between health literacy, nutritional literacy, knowledge, motivation and sun exposure. Second, the use of vitamin D supplements should be further investigated because vitamin D supplements may be a negative motivation to sun exposure. Third, since this study has been conducted in Iran, whose lifestyle and cultural context may be different from those of other countries, the current findings may be different from those that do not match the rest of the world.

Conclusion

The findings of the current study showed that health and nutritional literacy was significantly associated with knowledge but not significantly associated with attitudes for sunlight exposure. Rather, health and nutritional literacy mediated the relationships between knowledge and sunlight exposure. Our study suggests that health professionals should consider the level of health literacy and nutritional literacy of individuals when conducting health education on sun exposure as a way to receive vitamin D. Further research is needed to better understand the structure of such complexity and high quality intervention studies are needed to establish causal outcomes.

Abbreviations

SEM: Structural Equation Modelling

BMI: body mass index

HELIA: Health Literacy for Iranian Adult

NLS: The Nutrition Literacy Scale

NFI: normed fit index

CFI: comparative fit index

RMSEA: root-mean-squared error associated

IPAQ: [international physical activity questionnaire](#)

SPF: Sun Protection Factor

BP: Blood pressure

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the Tehran University of Medical Sciences (IR.TUMS.VCR.REC.1396.4028). Participants were informed in detail about the study purpose before completing their written informed consent.

Consent for publication

Not applicable.

Availability of data and materials

Derived data supporting the findings of this study are available from the corresponding author [SSb] on request.

Competing interests

The authors declare there is no conflict of interest.

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Authors' contributions

S SB developed the idea for this research and prepared the protocol. N SF, Z A and N J collected data. N SF, AA HM, M Y, A M and S SB contributed to statistical analyses and data interpretation. N SF prepared the first draft of the manuscript. Disagreements were resolved by consensus and all authors read and S SB approved of the final manuscript.

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Tables

Due to technical limitations, the tables are only available as a download in the supplemental files section.

Figures

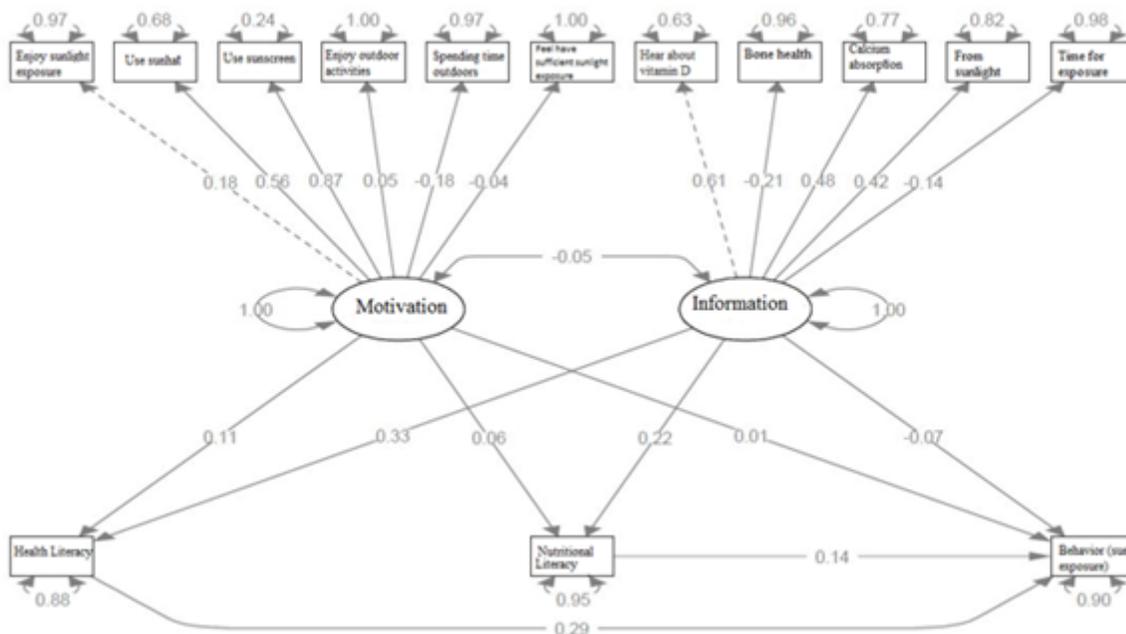


Figure 1

Testing whether health and nutritional literacy is a mediator of the relationships between knowledge and sun exposure and between attitude and sun exposure.

Supplementary Files

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