



Research article

Health literacy in dietary supplement use among working-age groups: systematic review and meta-analysis

Ungsinun Intarakamhang^{*}, Pitchada Prasittichok

Behavioral Science Research Institute, Srinakharinwirot University, Bangkok, Thailand

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ABSTRACT

Background: Globally, dietary supplement use (DSU) is very popular against COVID19. This study aims to investigate the characteristics of research on health literacy (HL) in DSU and compare HL among working-age groups by reviewing related research between 2011 and 2021 in PubMed, SCOPUS, ClinicalKey, Google Scholar and ThaiJO.

Methods: Twenty-five articles that met the inclusion criteria were selected for study and analyzed using Cohen's d. **Results:** The results showed that HL affected dietary supplement (DS) consumption behavior among working-age groups with an average effect size of 0.423 (95% CI = 0.249–0.598), followed by disclosure of DSU with an average effect size of 0.220 (95% CI = 0.087–0.353). No effect was found on awareness of dietary supplement advertisements.

Conclusion: The discovery of such knowledge is a significant contribution to public health, leading to the development of interventions and policies for enhancing HL in DSU e.g. organizing knowledge-sharing workshops on DSU and building support networks across all sectors.

1. Introduction

Globally, there is widespread consumption of dietary supplement (DS) due to the rapid growth of online DS businesses in the country and consumers' increasing awareness of self-care aimed at restoring body health, improving blood circulation, enhancing memory, and slowing down ageing, etc. especially among working-age groups [1, 2]. In a study by Hoseini et al. indicated that people spend more money on dietary supplements for the following reasons: 1) personal factors including sociodemographic characteristics, belief about the benefits of DS, history of illness, physiological conditions, and lifestyle factors and 2) socio-economic factors including subjective norms, the price of food, and commercial consideration of the sectors involved in the production and sale of DS [3]. In this study, dietary supplements were defined in the US Drug Supplement Health and Education Act of 1994 regarding food supplements and EFSA Scientific Committee -European Union, food supplements refer to products consumed in addition to conventional foods containing nutrients or other substances in forms of tablets, capsules, powders, flakes, liquids or others which are not conventional foods for consumers who expect certain health benefits, including cosmetics which refer to substances intentionally used by applying, rubbing,

massaging, sprinkling, spraying, dropping, putting on, treating with smoke or taking any action to any external part of human body for cleanliness, beauty, odor protection or body treatment, including skin-care products [4, 5].

Considering the importance of health literacy (HL), the Ministry of Public Health, Thailand enhanced Thai people's HL and self-care awareness through community engagement by supporting community self-care and building community-based centers for sharing HL following five principles: 1) building a health literate organization consisting of policies, budgets, personnel potential development, employee engagement in role model design, and a HL project management team, 2) promoting health literate people who can manage their overall health both individually and collectively, 3) developing health literate staff with two-way communication skills and the ability to improve health motivation among people, 4) producing health literate media and technology, and 5) supporting health literate hospitals or communities by building learning centers, creating symbols, maps, service signs, and key messages to enhance self-care knowledge, providing volunteers, etc. [6]. The government's campaign aims to develop HL in hospitals and local communities to reduce the risks of diseases with high mortality rates such as diabetes, hypertension, kidney disease, and cardiovascular diseases [7].

^{*} Corresponding author.

E-mail address: ungsinun@gmail.com (U. Intarakamhang).

However, little attention has been paid to the promotion of HL among consumers of healthcare products. Due to the rapid growth of the DS market, Thai people are more exposed to exaggerated advertising of DS products potentially with false FDA approval and dangerous ingredients added to accelerate desirable physical changes. Exposure to misleading advertisement of healthcare products can cause harm to people’s health.

For the above reasons, the researchers were interested in exploring HL in DSU among working-age groups by performing systematic review and meta-analysis to summarize the findings of selected studies and propose approaches to Thai people’s health problems regarding HL in DS consumption.

2. Methods

The researchers performed a systematic review and synthesis of knowledge concerning HL in DSU among working-age groups, using the procedure based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance [8], and calculated the effect sizes of HL affecting DS consumption among working people gathered from related studies, using meta-analysis. Ethical approval was obtained from the Institutional Review Board of Srinakharinwirot University with certificate No. SWUEC-210/2564.

2.1. Search strategy

The study population consisted of research articles related to HL in DSU among working-age people that were published in the past ten years (since 2011) in the electronic databases of PubMed, SCOPUS, ClinicalKey, Google Scholar, and ThaiJO that are used in the healthcare profession. After keyword searching, the researchers found a total of 740 relevant articles. The keywords used are presented in Table 1.

2.2. Selection criteria

A sample was selected from the population according to the following criteria; the papers must be accessible and available for full-text download. After the criteria-based searching and selection, a total of 54 articles were obtained for a systematic review.

The inclusion criteria established for selecting the study sample were as follows; 1) papers presenting research methodology such as quantitative research, qualitative research, and mixed methods research, 2) papers published in English or Thai, 3) papers discussing DSU, 4) papers measuring HL or DSU and/or alternative medicine use using scales (for quantitative research) and interview forms (for qualitative research), 5) papers involving working-age people (university students included because many undergraduate students were both employed full-time and enrolled part-time course in the university), and 6) papers published between 2011 and 2021.

The exclusion criteria; 1) book chapters, editorial notes, archives, and others alike, 2) papers containing only titles and abstracts, 3) academic articles, and 4) papers involving retirees aged over 60 years or students in upper secondary level and below.

Table 1. The keywords used in database searching.

Database	Keywords	Paper No.
PubMed	("health literacy" [MeSH Terms] OR ("health" [All Fields] AND "literacy" [All Fields]) OR "health literacy" [All Fields]) AND ("dietary supplements" [MeSH Terms] OR ("dietary" [All Fields] AND "supplements" [All Fields]) OR "dietary supplements" [All Fields] OR ("dietary" [All Fields] AND "supplement" [All Fields]) OR "dietary supplement" [All Fields] OR "complementary alternative medicine" [Title/Abstract])	59
SCOPUS	TITLE-ABS-KEY ((health AND literacy) AND ((Dietary AND Supplement) OR (Complementary AND Alternative AND Medicine)))	140
ClinicalKey	"Health literacy" and "dietary supplement" OR "complementary alternative medicine"	79
Google Scholar	"Health literacy dietary" OR "supplement" Health literacy complementary" OR "alternative medicine"	313
ThaiJO	"Dietary supplements" AND "health"	149
Total		740

2.3. Data collection and analysis

2.3.1. Research instruments

1. Data Extraction Form – The extracted data consisted of; researcher name(s), year of publication, research design, sample group, research instruments, and significant findings

The data extraction form with the above items was used by two independent researchers to extract data from each study. After extracting data from the selected works, the researchers summarized the obtained data in a table to present the overall picture of research studies on HL in DSU among working-age groups.

2. Quality Assessment Checklist – Applying the quality assessment criteria by Kmet, Lee, and Cook (2004) [9], the quality assessment checklist consisted of; 1) quality assessment checklist for quantitative research (14 items) – 2 points for “Yes”, 1 point for “Partial” and 0 point for “No” and 2) quality assessment checklist for qualitative research (14 items) – 2 points for “Yes”, 1 point for “Partial” and 0 point for “No”. Items that were not applicable for a study would be marked N/A and excluded from the total score calculation. The quality assessment checklist was used by two independent researchers to measure the quality of each selected study.

2.3.2. Data analysis

Different types of data analysis were conducted according to the research objectives.

1. To study the characteristics of studies on HL in DSU among working-age groups, descriptive analysis was performed to describe and present data such as publication years, research designs, samples, instruments, and significant findings in numbers and percentages.
2. To compare the effect sizes of HL affecting DSU among working-age groups, a meta-analysis was performed as detailed below.
 - 2.1 Cohen’s d effect sizes were calculated using the Practical Meta-Analysis Effect Size [10]. Because different studies have different characteristics in terms of research types, study samples, etc., heterogeneity or variation in findings between studies was examined using Cochrane’s Q statistic. A statistically significant result means that studies are different. The I^2 statistic describes the percentage of variation across studies due to heterogeneity rather than chance. A higher value of I^2 means larger differences between studies whereas $I^2 = 0$ suggests no heterogeneity [11]. To calculate average effect sizes, the random effects model was used for a non-significant Cochrane’s Q and the fixed effects model for a significant Cochrane’s Q.
 - 2.2 The detected differences between studies were analyzed to determine independent research characteristic variables. The effects of research characteristic variables were explored using multiple regression to explain the variance in effect sizes. The differences between effect sizes were compared and classified,

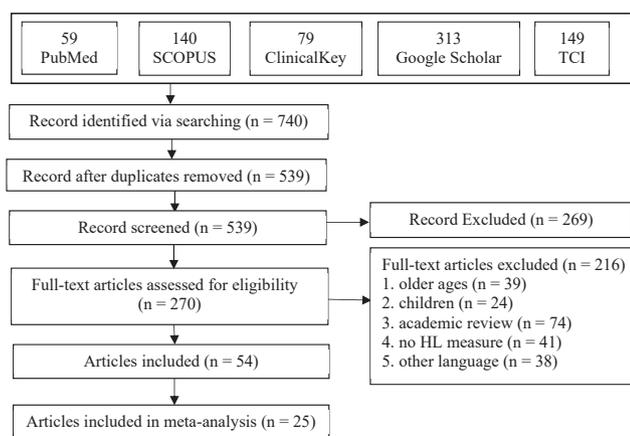


Figure 1. PRISMA flowchart.

using the one-way ANOVA or the independent samples t-test, according to subgroups of research characteristic variables that could explain the variance.

2.3 Publication bias was examined using Begg’s funnel plots [12]. A p-value greater than 0.05 or a non-significant p-value means that the funnel plot is symmetrical, thus suggesting no existence of publication bias.

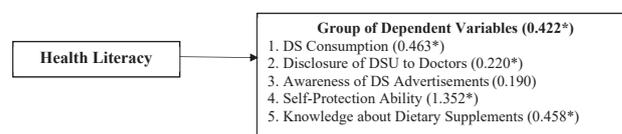
3. Results

The researchers searched for research articles related to HL in DSU among working-age groups in different databases and entered data such as research names, researcher names, and publication years in Microsoft Excel. Search results led to a total of 740 articles across PubMed (n = 59), Scopus (n = 140) ClinicalKey (n = 79), Google Scholar (n = 313) and TCI (n = 149)) databases and screened to remove duplicates as well as studies that are not published in English or Thai, contain only abstracts or editorial notes, and not available in full text. After the screening process, 270 articles remained and were passed to two independent researchers for review and selection based on the inclusion and exclusion criteria. As a result, 25 articles were obtained for meta-analysis [13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37]. In addition, regarding the study selection criteria, the researchers limited meta-analysis to quantitative studies with statistical data sufficient for standardized index calculation. Therefore, qualitative research and studies without sufficient data for effect size computation were excluded. The results are presented in Figure 1.

3.1. Characteristics of studies selected for meta-analysis

The analyzed characteristics of studies selected for meta-analysis consisted of publication years, research designs, study samples, instruments, and statistics used in data analysis. The results are summarized below.

The selected articles were classified according to their publication years. The results showed that most articles were published in 2020 (7



More than two studies, no Effect size not statistically significant

Figure 2. Effects of HL on DSU among working-age groups.

articles, 28.0%), followed by 2019 (4 articles, 16.0%) and 2018 (3 articles, 12.0%). In regard to research designs, most studies used a cross sectional design (13 studies, 52.0%), followed by a descriptive design (9 studies, 36.0%) and an experimental design (2 studies, 8.0%).

In terms of samples, most studies were conducted among general adults (6 studies, 24.0%), followed by general patients (4 studies, 16.0%), pregnant women (4 studies, 16.0%), and university students (3 studies, 12.0%). Considering the types of samples, most studies involved clinical groups (16 studies, 64.0%), followed by non-clinical groups or general people (9 studies, 36.0%). In regard to assessment instruments, most studies used HL assessment tools (23 studies, 92.0%), followed by DS assessment tools (19 studies, 76.0%) and HL interventions (2 studies, 8.0%).

In terms of statistics used for data analysis, all of the studies used descriptive statistics (25 studies, 100.0%); in addition, 15 studies used logistic regression (15 studies, 60.0%) and chi-square (11 studies, 44.0%).

3.2. Comparison of effect sizes of HL affecting DSU among working-age groups

The research synthesis was carried out using meta-analysis to examine the effect sizes of HL affecting DSU among working-age total groups. In the effect size (d) calculation, the research paper topics were taken into account. Because some studies aimed to study the effects or relationships between many variables, they contributed more than one effect size to the meta-analysis.

As shown in Table 2, all 28 effect sizes had heterogeneity variance ($I^2 = 98.14\%$, $p = 0.000$); therefore, the random-effects model was used. The dependent variables (DSU) affected by HL had a significance level of .01 and an average effect size of 0.423 (95% CI = 0.249–0.598).

Considering the effects of HL on each variable, the results indicated that HL had the most effect on DS consumption with an average effect size of 0.463 (95% CI = 0.240–0.685), followed by disclosure of DSU with an average effect size of 0.220 (95% CI = 0.087–0.353); however, no effect was found on awareness of DS advertisements. The results also showed that HL influenced self-protection ability with a large average effect size (>0.50) as well as knowledge about dietary supplements with a medium average effect size (0.30–0.50).

The above results are summarized in Figure 2.

Considering the effects of HL on DS consumption of each group (general adults, general patients, pregnant women, and university students) as shown in Table 3, found that 19 effect sizes had heterogeneity variance ($I^2 = 98.57\%$, $p = 0.000$); therefore, the random-effects model

Table 2. Analysis of effect sizes of HL affecting DSU among working-age total groups.

DSU Variables	No. of Effect sizes	Weighted Average Effect Sizes	Cochran’s Q (df)	I^2	Test for Overall Effect
DS Consumption	19	0.463 [0.240–0.685]	1261.190 (18)**	98.57	4.077**
Awareness of DS Advertisements	5	0.190 [-0.028–0.408]	53.021 (4)**	92.45	1.71
Disclosure of DSU to Doctors	2	0.220 [0.087–0.353]	1.141 (1)	12.34	3.243**
Self-Protection Ability	1	1.352 [1.322–1.382]	-	-	-
Knowledge about Dietary Supplements	1	0.458 [0.392–0.524]	-	-	-
Total	28	0.423 [0.249–0.598]	1447.939(27)**	98.14	4.748**

**p < .01

Table 3. Analysis of effect sizes of HL affecting DSU among working-age each group.

Sample Group	No. of Effect sizes	Weighted Average Effect Sizes	Cochran's Q (df)	I ²	Test for Overall Effect
General adults	3	0.381 [-0.176–0.938]	127.834 (2)**	98.44	1.342
Patients	12	0.543 [0.216–0.869]	1037.148 (11)**	98.94	3.257**
Pregnant women	2	0.369 [0.063–0.674]	7.058 (1)**	85.83	2.361*
University students	2	0.224 [0.067–0.380]	3.885 (1)*	74.26	2.805**
Total	19	0.463 [0.240–0.685]	1261.190(18)**	98.57	4.077**

*p < .05
**p < .01

was used. HL had influenced DSU significantly at .01 with an average effect size of 0.463 (95% CI = 0.240–0.685).

According to Table 3 Considering each sample group, the findings indicated that HL had the greatest effect on DSU in the patient group with an average effect size of 0.543 (95% CI = 0.216–0.869) followed by pregnant women with effect size of 0.369 (95% CI = 0.063–0.674) and university students with effect size of 0.224 (95% CI = 0.067–0.380). However, HL did not affect DSU in the general adult group.

3.3. Assessment of variance in effect sizes classified by research characteristic variables

The heterogeneity among study results was investigated using Cochran's Q statistic. A statistically significant result indicates a difference in findings between studies. The detected variance was analyzed to determine independent research characteristic variables. Using multiple regression analysis, the effects of research characteristic variables were explored to explain the variance in effect sizes. Since meta-analysis requires many studies, multiple regression analysis is not recommended when studies are fewer than ten [38]. The independent and dependent variables were research characteristics and effect sizes, respectively. The differences between effect sizes were compared and classified, using the one-way ANOVA, according to subgroups of research characteristic variables that could explain the variance. The results are summarized below.

3.3.1. HL affecting DSU among working-age groups

The researchers examined the heterogeneity of variance in HL's effect sizes affecting DS consumption and discovered heterogeneity variance among 19 effect sizes (I² = 98.57%, p = 0.000). To determine independent research characteristic variables, the researchers further analyzed the detected variance.

According to Table 4, descriptive research could explain 16.2% of the variance in HL's effect sizes affecting DSU at a significance level of 0.05. In other words, one research characteristic variable i.e. descriptive research (F = 4.490, df = 1, p < 0.05) caused a statistically significant difference between the effect sizes. The findings indicated that at least one pair of the mean values of one variable was different.

A comparison of the average effect sizes of descriptive research was conducted. The results showed that descriptive research significantly caused the average effect sizes to differ at a significance level of 0.05 (t = 2.119, p < 0.05); in addition, the average effect sizes of descriptive

Table 4. The effect sizes of HL on DSU by multiple regression analysis.

	Source of variance	SS	Df	MS	F	Sig
Descriptive research	Regression	1.013	1	1.013	4.490	0.049*
	Error	3.837	17	0.226		
	Total	4.850	18			
R ² = 0.510, Adjusted R ² = 0.260						

*p < .05

research (M = 0.809, SD = 0.599) were higher than those of non-descriptive research (M = 0.312, SD = 0.413).

3.3.2. Part 4 examination of publication bias

The publication bias was examined using Begg's funnel plots. A p-value greater than 0.05 or a non-significant p-value suggests a symmetrical funnel plot and thus no existence of publication bias. The obtained results (Kendall's tau = 0.141, p = 0.125) showed that the effect sizes included in this study were symmetrical, indicating no publication bias. Therefore, it can be concluded that the results of this meta-analysis are trustworthy.

4. Discussion

This present study is one of the few that investigate the effects of HL on DSU among working people. The findings of this study showed that HL had the most effect on DS consumption because health literate people can access and study DS information and make appropriate decisions regarding DS selection and consumption [39]. These results are consistent with Pitug et al. (2020)'s cross-sectional study that explored the influence of HL on DSU among 1,200 people above 18 years of age and discovered the effects of sufficient and excellent levels of HL regarding health information access and appraisal on DSU [25]. The results are also in line with Sriratai et al. (2021)'s study that investigated factors affecting DS consumption among working-age groups and found that a high level of HL regarding access to health information affected DS consumption [40].

On the other hand, this study found no effect of HL on awareness of DS advertisements, which possibly resulted from the insufficiency of relevant data. This observation indicated the individual and cultural differences are the factors influencing awareness of DS advertisements. According to previous research, however, HL affects an individual's awareness of the dangers of DS products, leading to their prompt avoidance of buying and consuming unsafe dietary supplements [41]. Similarly, to the above cited paper, the level of HL was also found to negatively correlate with trust in advertising dietary supplements [42].

There are three limitations to this study. Firstly, the researchers were not able to classify the data according to types of disease or types of assessment due to the limited number of included studies. Secondly, using a self-administered questionnaire to assess HL and DSU could cause deviation, especially recall bias, in the assessment. For the latter limitation, future studies should consider using other assessment tools for assessing HL and DS consumption. Thirdly, several articles were excluded from the meta-analysis criteria. Therefore, the next studies should increase the objective of qualitative data synthesis for interesting articles related to HL in DSU.

5. Conclusion

Health literacy and Disclosure of DSU to doctors were affecting DSU among working-age groups. In addition, HL had no influence on awareness of dietary supplements. However, the paper samples had a limitation on the quantitative study selection. Therefore, health

providers should develop HL, Disclosure of DSU to doctors, and awareness among adults for improving suitable DSU behavior.

Declarations

Author contribution statement

Ungsinun Intarakamhang, Pitchada Prasittichok: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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