Psychometric Properties of a Developed Questionnaire to Assess Knowledge, Attitude and Practice (KAP) Regarding Vitamin D Nutrition

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Abstract

The aim of this study was to develop a valid and reliable questionnaire to assess vitamin D-related knowledge, attitude and practice (KAP) in Iranian adults who may be at increased risk of vitamin D deficiency. This study was conducted on 527 subjects, aged ≥20 years from Public health care centers in Tehran, Iran. Based on results of literature review and in-depth interviews, the 38-item vitamin D-related KAP questionnaire with four subscale was developed: 1) general knowledge; 2) nutritional knowledge; 3) attitudes; 4) behaviors. Validity of the developed vitamin D-KAP questionnaire was assessed, utilizing face, content, and construct validity methods. Internal consistency was calculated to assess reliability of the current developed questionnaire. A total of 572 (54.1% female) adults, aged 30.2±7.9 years, participated in the study. All items were perceived as relevant and comprehendible by participants. Content validity was confirmed by the panel of experts. The internal consistency, as measured by Cronbach's alpha coefficients, exceeded the minimum reliability standard of 0.60 for four subscales. The EFA suggested a four-factor construct and the results of the CFA indicated acceptable fit indices for the proposed model. No ceiling effects were observed except for general knowledge (1.2%). Floor effects detected were 0, 1.1, 2.4, and 8.7% for practice, attitude, general knowledge, and nutrition knowledge, respectively. General knowledge had the highest score (79.59±14.52) and nutrition knowledge, the lowest score (42.58±20.40) among the four sub-scales. Results confirm the initial validity and reliability of the vitamin D-related knowledge, attitude and practice questionnaire. Further investigations in different urban and rural population are recommended.

Key words: Vitamin D, Knowledge, Attitude, Practice, Validity, Reliability

Introduction

Besides the central role of vitamin D in mineral metabolism, data reveals that low levels of this important micronutrient might be associated with risk of various cancers, cardiovascular disease, diabetes, autoimmune disorders, infection, chronic kidney disease, and muscle metabolism [1-3]. Worldwide, one billion people belonging to different ethnicities and age groups suffer from vitamin D deficiency[4], prompting the Institute of Medicine (IOM) to update the dietary intake requirements of calcium and vitamin D in 2011[5]. In Iran several studies from different urban areas have shown a high prevalence of vitamin D deficiency in different sub groups, including women, adolescents and taxi drivers [6-8].

Despite sufficient evidence on the various factors responsible for vitamin D deficiency including lack of sun exposure and dietary intake; several studies document controversial data on the ignorance and confusion regarding the role of sunlight in vitamin D production, the function and sources of vitamin D, and the negative attitude and behavior toward sunlight not only in general population but also among medical practitioners [9-12]. As is evident, vitamin D deficiency is a behavioral phenomenon, and like other behavioral patterns, it is hence reasonable to hypothesize that vitamin D-related behaviors would be influenced by individuals' knowledge and attitudes. Although existing data show that knowledge and attitude do not fully explain vitamin D deficiency because several socio-environmental factors may help to define vitamin D deficiency status, they are important mediators shaping individuals' behaviors. Several studies among university and school students, general adult populations, and athletes indicate poor knowledge and negative attitudes toward vitamin D [11-18], indicating confusion between sun exposure, skin cancer, and vitamin D production; hence understanding the related knowledge of general

72 populations related knowledge, attitude and practice (KAP) regarding vitamin D could be a
73 crucial forward step in developing health promotion programs.

74 Limited instruments have been already developed to assess individuals' vitamin D status. In
75 some previous studies on vitamin D, KAP was evaluated using a number of questions rather
76 using a developed structured questionnaire [9,10,15-17]. On the other hand the psychometric
77 properties of structured questionnaires used in some other studies were mainly assessed by face
78 and content validity and none of them utilized statistical approaches to examine construct
79 validity of the applied instruments. While vitamin D-related behaviors are rooted in culture,
80 social norms, religion, personal expectations and environmental reinforcements, most of the
81 existing questionnaires have been developed in Western communities [9,12,15,17] with a high
82 level socio-environmental concordance with Eastern countries, in particular with Muslim
83 populations. To fill the gap in current literature, this study is one of the first efforts aimed at
84 developing a valid and reliable questionnaire to assess vitamin D-related KAP in Iranian adults
85 who are at increased risk of vitamin D deficiency.
86

87 **Material and methods**

88 **Participants and data collection**

89 Participants were adults, aged ≥ 20 years selected and recruited from public health care centers in
90 Tehran. The ethics committee of the Research Institute for Endocrine Sciences (RIES), Shahid
91 Beheshti University of Medical Sciences approved the study. All participants provided written
92 informed consent before the interviews and explicit permission was sought for audio taping.
93

94 **Measures**

The final version of the knowledge, attitude, and practice questionnaire included 38 items (general knowledge-11, nutritional knowledge-5, attitude-12 and practice-10), developed through literature review and face to face interviews. Demographic questionnaire included information on age, gender, education, occupation, maternal status, history of vitamin D deficiency, and vitamin D supplements.

Scale development procedure

Item generation

Scale development began with item generation and was then followed by different steps assessing of face, content, construct validity, and reliability. A review of related literature and in-depth interviews with 15 individuals (5 male and 10 female) belonging to high and low socioeconomic status were conducted to identify all aspects of KAP. Participants were recruited from endocrine clinics of Tehran, the capital of the Islamic Republic of Iran. The criteria for selection of participants were: 1. to confirm diagnosis of vitamin D deficiency 2. participants' willingness to share their experiences. The main researcher contacted potential participants to explain the objectives and process of the current research, and if the participants agreed to take part in the research, an interview was scheduled. Overall, fifteen interviews were conducted (duration=30 minutes) and audio-recorded in a private room using a semi-structured guide consisting of open-ended questions. This enabled respondents to fully explain their conception and experiences regarding the importance of vitamin D and its sources, behaviors related to vitamin D intake, causes of vitamin D deficiency, how to prevent or treat vitamin D deficiency, and sources of information about vitamin D. All interviews recorded were transcribed in Farsi word by word. All items were extracted according to the participant's responses and related

existing literature. The final pool of 93 items were categorized into 8 domains: Importance of vitamin D deficiency (13 items), prevention and treatment (36 items), attitudinal barriers to sun exposure (16 items), attitudinal barriers to diet containing vitamin D (5 items), attitudinal barriers relating to vitamin D supplements (10 items), behaviors related to sun exposure (7 items), behaviors related to diet (2 items), and behaviors related to vitamin D supplements (4 items).

Validity assessment

Validity of final items was assessed through content, face, and construct validity methods. Content validity through qualitative and quantitative approaches was performed. To confirm qualitative content validity, a panel of 12 specialists in health education, endocrinology, and nutrition completed the questionnaire and were asked to comment independently on the necessity, relevance, clarity, and simplicity of each item. The panel was asked to comment on individual items in relation to the accuracy and style. Items were modified, based on the panel comments. In the next step, to confirm quantitative content validity, content validity ratio (CVR) and content validity index (CVI), were calculated; necessity of items was assessed using a three-point rating scale: 1) not necessary, 2) useful but not essential, and 3) essential. A CVR for total scale was computed, according to the Lawshe scores [19]. The relevance of the items was also assessed, using a four-point rating scale: 1) not relevant, 2) slightly relevant, 3) relevant, and 4) very relevant. The CVI of each question was determined by the proportion of experts rating the item, a three or a four. Based on the CVR and CVI results, further modifications were made.

Regarding face validity, the questionnaire was given to 15 individuals with different educational levels, to ascertain whether the initial items were relevant to them and, if so, how important each issue was in their daily lives.

To assess construct validity, a total of 572 adults participated in the study. To maximize the heterogeneity of the sample, subjects were recruited from health care centers of two diverse socioeconomic areas of Tehran, one located in the north and the other in the south of Tehran, where the socio economic status of people is mostly high and low, respectively. Exploratory and confirmatory factor analysis (EFA and CFA) were conducted not to reduce items but rather to help place items in the appropriate domains. The average length of time for subjects to complete the test was 20 minutes.

Reliability assessment

After performing construct validity and detection of questionnaire subscales, the reliability was assessed, using internal consistency by calculating Cronbach's Alpha coefficient.

Statistical analysis

Range of measurement was based on the percentage of scores at the extremes of the scaling ranges, the maximum (ceiling effect) and the minimum (floor effect) possible scores[20]. Scale internal consistency was determined by calculating Cronbach's Alpha coefficient, values >0.6, being considered as satisfactory. Exploratory factor analysis was used to assess construct validity and derivate four subscales. Kaiser-Meyer-Olkin (KMO), Bartlett's test of sphericity, and total variance explained were used for the evaluation of model adequacy. Principal component extraction method and varimax rotation with Kaiser Normalization was conducted to estimate factor loadings. Factor loadings >0.3 were considered as substantial and items higher than this criterion remained in the constructs. Confirmatory factor analysis with the weighted least squares (WLS) estimation method was performed to test whether the data fit the hypothesized

measurement model extracted by EFA. Asymptomatic covariance matrix was applied as a weighted matrix.

Goodness of fit indices and reasonable threshold levels of these indices for CFA were considered as $\chi 2/df<3$, root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) <0.08, as well as comparative fit index (CFI), goodness of fit index (GFI), normed fit index (NFI), and incremental fit index (IFI) >0.9 [20].

Modifications of the models in covariance structure were performed, based on the largest drop in the overall value of the test statistic to achieve acceptable goodness of fit indices. Conceptual measurement models were tested with and without proposed modifications [19]. Statistical analysis was performed using SPSS 22.0 (SPSS Inc., Chicago, IL) and LISREL 8.80 (Scientific Software International Inc., 2007). The protocols of this study were approved by the institutional ethics committee of the RIES, affiliated to the Shahid Beheshti University of Medical Sciences.

Results

A total of 572 (54.1% female) adults, aged 30.2±7.9 (range: 18-68) years, participated in the study. Socio-demographic status of participants is reported in Table 1. Participants were more likely married, employed, and lived in the north of Tehran. Almost half the subjects had academic education; only a few had histories of vitamin D deficiency and supplement use was rather low. Most subjects had no children (54.7%). Based on face validity results, some items needed to be revised, mostly due to ambiguity, whereas the rest were generally easy to read and understand by subjects.

A satisfactory level of agreement was found (CVI = 0.89) among panelists suggesting that the scale had good content validity and the CVR in this study for total scale was 0.86 indicating a

satisfactory result. Findings regarding CVR and CVI confirmed the quantitative content validity of 49 items.

In case of EFA, Kaiser-Meyer-Olkin (KMO) showed a reasonable fit of the model (KMO=0.658), and the Bartlet's test ($\chi 2$=2762.9, df=1081, P<0.001) confirmed the sphericity assumption. The factor analysis identified four factors with eigen values 2, factors which made intuitive sense and were characterized as follows: General knowledge, nutrition knowledge, attitude, and practice. The final analysis was repeated with these four factors using a varimax rotation.

Table 2 presents the four items included in the factor analysis with their associated factor loadings, with the 38 items chosen for the final questionnaire bolded in the "factor loading" column. Overall, the total percentage of variance was 25.57 and percentage of variance explained by general knowledge, nutrition knowledge, attitude, and practice, was 6.99, 5.15, 6.99, and 6.81, respectively.

The mean±SD subscale scores and number of items in each subscale are presented in Table 3. To calculate subscale scores, all items in the corresponding subscale were summed and transformed to a 0-100 scale. No ceiling effects were observed except for general knowledge (1.2%). Floor effects detected were 0, 1.1, 2.4, and 8.7% for practice, attitude, general knowledge, and nutrition knowledge, respectively. General knowledge had the highest score (79.59±14.52) and nutrition knowledge had the lowest (42.58±20.40) among the four sub-scales.

Based on 47 items which behave as indicators and four constructs, detected from EFA, we conducted the primary CFA on 287 randomly selected cases. Two questions, q34 and q36 had no significant factor loadings and were excluded from analysis. The second hypothesized CFA model, with 38 indicators and four constructs had acceptable goodness of fit indices (Table 4).

Figure1 indicates the conceptual framework of CFA model with four construct and 38 indicators. Standardized factor loadings are displayed above pathways. Also correlation between constructs and its significance criteria (T-values) was found to be significant upon two sided pathways.

For "General Knowledge" construct, the minimum and maximum loadings are related to q5 (λ=0.23, T=2.16) and q19 (λ=0.39, T=4.71) respectively. For the "Nutrition Knowledge" construct the minimum and maximum loadings are related to q12 (λ=0.28, T=2.53) and q15 (λ=-0.59, T=-5.25) respectively. For the "Attitude" construct the minimum and maximum loadings are related to q33 (λ=0.22, T=5.66) and q26 (λ=0.60, T=11.83) respectively, and for the "Practice" construct the minimum and maximum loadings are related to q40 (λ=-0.29, T=-10.40) and q43 (λ=-0.63, T=-21.90) respectively.

Discussion

This study is one of the first efforts to develop and assess the psychometric properties of a KAP questionnaire regarding vitamin D among an urban Eastern-Mediterranean population. Our results support the initial reliability and validity of this developed questionnaire. In this study, 25 questionnaires (4.4%) had more than 15% missing items and were excluded from the analysis. This low percent of missing values showed the acceptable feasibility of the questionnaire. Internal consistency of different constructs showed that Cronbach's alphas generally exceeded the standard of >0.60, and confirming the reliability of the current questionnaire.

In the case of quantitative content validity, a satisfactory level of agreement (CVI = 0.89 and CVR = 0.86) was found among panelists, suggesting that the scale had a good content validity. Despite the substantial theory of KAP which considers three knowledge, attitude and practice constructs in the developed questionnaire, the current results of exploratory factor analysis (EFA) suggested a four-factor structure as an optimized structure that emerged from this item

pool. In this regard, the construct of knowledge was divided into two factors:1) Nutritional knowledge which contained questions related to nutrition and 2) General knowledge which encompassed non nutritional vitamin D-related questions, including the importance of vitamin D, sun exposure and using supplements. This four factor structure, confirmed by confirmatory factor analysis (CFA), indicates the acceptable fit of the proposed models.

The above mentioned four factor structure of the current questionnaire, allow us to conduct a deeper analysis of vitamin D-related knowledge in the population studied. Based on the current results, despite participants having an acceptable general knowledge regarding vitamin D, there was a lack of nutritional awareness regarding vitamin D in both men and women, findings were in agreement with the results of other studies that reported poor awareness on nutritional sources of vitamin D in general population [11,13,21]. Toher et al revealed that almost 20% of their study population had no knowledge of any nutritional sources of vitamin D, compared to those who knew some resources, and there was apparent confusion about the best sources of this vitamin [22]; thus, considering these results, assessing individuals' general and nutritional vitamin D-related knowledge separately seems essential definitely beneficial in planning health promotion programs.

Our results showed an acceptable known group validity of the developed vitamin D KAP questionnaire. In this study, as hypothesized, women had significantly higher general vitamin-D-related knowledge and lower practice, compared to men. Consistent with our findings, previous articles marked lack of knowledge in their study population [23]. Higher awareness regarding vitamin D in women was mainly attributed to their desire to obtain health information from media and professionals. However poorer practices in women could be a result of several socio-environmental barriers, limiting women from sun exposure and also their desire to use sunscreen.

The current results showed significant higher scores in general knowledge and attitude among individuals aged ≥ 30 years, in agreement with findings of an earlier study by Kung et al. Several personal and environmental factors could influence this relationship, e.g. middle-aged people, especially women, are advised to take calcium and vitamin D supplements to prevent osteoporosis and its complications [11,24]. Furthermore, it is reasonable to assume different vitamin D-related KAP scores in people with different educational level. Based on our results, compared to those with primary and secondary education, higher educated individuals have significantly higher knowledge and poorer practices, similar to a study from Kuwait, which also reported higher levels of vitamin D-related awareness in educated people [13]; this conflict between knowledge and behavior among educated people maybe a result of educated people spending more time indoor and having less leisure time for sun exposure.

The main strengths of this study are its prospective and population-based design However, a number of limitations should also be considered: First, individuals were selected from only one city of Iran and further investigations of other Iranian population are recommended. Furthermore, due to unavailability of the participants for the following 2-weeks assessment we were unable to conduct test re-test and confirm reproducibility of the questionnaire.

In conclusion, our results confirm the initial validity and reliability of the developed vitamin D KAP questionnaire. Further investigations in different urban and rural populations are recommended.

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278 Tehran, Iran. All authors read and approved the final manuscript.

279 **Author contribution**

280 P A, G A, and A A conceptualized and designed the study and drafted the initial manuscript. H S
281 and M K analyzed and interpreted the data. A A, P M, and F A supervised the project and
282 approved the final version of the manuscript as submitted**.**

283 **Conflicts of interest**

284 The authors declare no conflict of interest.

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Table 1. Baseline characteristics of the participants (n=572)

Variable	Number	%
Female	308	54.1
Married	397	70.0
Parity		
0	313	54.7
1	127	22.2
≥ 2	132	23.1
Education		
Primary	74	13.0
Secondary	222	39.0
Higher	273	48.0
Employed	324	58.1
Residential area		
North of Tehran	184	36.0
South of Tehran	327	64.0
Vitamin D deficiency	64	11.3
Intake of vitamin D supplement	148	26.1

Table 2. Factor loading matrix for the vitamin D KAP questionnaire

		General k.	Nutrition K.	Attitude	Practice
1	People, who work indoors, are at high risk of vitamin D deficiency.	**.642**	-.156	.004	.059
2	Vitamin D intake over dietary recommendations could be harmful.	**. 599**	-.108	-.130	-.043
3	Elder people are at high risk of vitamin D deficiency.	**.498**	.149	.037	.102
4	Inappropriate dietary intakes are related to vitamin D deficiency.	**.495**	.280	-.074	-.083
5	Vitamin D supplement intake requirements, differs for different age groups	**.449**	.263	.110	-.092
6	Pregnant and lactating women are at high risk of vitamin D deficiency.	**.439**	-.012	.048	.040
7	Most of the vitamin D required is produced when the skin is directly exposed to the sun.	**.395**	-.171	.081	-.069
8	Currently, vitamin D deficiency is one of the most important health issues in Iran.	**.379**	.265	.227	.161
9	Bone pain and fatigue are among the vitamin D deficiency symptoms.	**.330**	.227	-.040	.133
10	Vitamin D supplement intake requirements differ in various seasons of the year.	**.321**	.127	.202	-.124
11	Both men and women are at risk of vitamin D deficiency.	**.320**	.068	-.106	.211
13	Fish is a dietary sources of vitamin D.	.394	**.336**	.097	-.042
14	Dairy products are a dietary sources of vitamin D.	-.125	**-.646**	-.051	-.100
15	Egg is a dietary source of vitamin D.	-.133	**-.571**	-.171	-.046
16	Meat and poultry of dietary sources of vitamin D.	.029	**-.526**	-.074	.044
17	Fruits are a dietary source of vitamin D.	.053	**-.300**	.051	-.052
20	Urbanization prevents sun exposure and production of required vitamin D.	.212	-.039	**.575**	-.261
21	Incapability to public places for outdoor activities prevents production of required vitamin D through sun exposure.	.235	-.151	**.558**	.005
22	Full time indoor occupations prevent production of required vitamin D through sun exposure.	.300	-.131	**.552**	-.089
23	Inefficient education regarding benefits of sun exposure prevents production of required vitamin D through sun exposure.	.323	-.061	**.531**	.070
24	The undesirable taste of sea foods is one of the barriers of providing and consuming of dietary sources of vitamin D.	.257	.140	**.467**	.019
25	In vitamin D deficiency, supplement intake is more effective compared to dietary intake and sun exposure.	-.182	.075	**.464**	.218
26	Taking vitamin D supplements is not recommended by physicians is wrong.	.036	-.080	**.430**	.019
27	Unwillingness of individuals is one of the barriers of vitamin D supplement intake.	.020	.161	**.424**	.192
28	Taking supplements is beneficial in case of not consuming dietary sources of vitamin D.	.081	.041	**-.401**	-.116
29	Taking supplements is necessary for treatment of vitamin D deficiency but not for prevention.	-.155	.135	**.398**	-.008
30	Permanent using of sunscreens on face, neck and hands prevents production of vitamin D through sun exposure.	-.078	.026	**.396**	.077
31	To prevent of vitamin D deficiency, taking supplement is an easier way compared to dietary intake and sun exposure.	-.255	.217	**.355**	.103
32	Taking supplement is only necessary in case of lack of exposure to sunlight.	.165	.258	**.301**	.057
33	High costs of dietary sources of vitamin D is one of the barriers of providing	.009	.257	**.303**	.257
38	For adequate exposure to sunlight, I engage in outdoor physical activities.	-.073	.038	.089	**.691**
39	To provide required vitamin D, I consume fortified milk.	-.063	.102	.119	**.661**
40	To provide required vitamin D, I consume fish at least twice a week.	-.032	.170	.125	**.618**
41	For adequate exposure to sunlight, I go out for walking every day.	.096	-.055	.055	**.616**
42	I use canopy covers in severe sun exposure.	-.122	.078	.038	**-.515**
43	For sufficient vitamin D, I take vitamin D supplement.	-.058	.242	.161	**.512**
44	I use sunscreen on my hands.	.069	-.178	.032	**-.455**
45	During the day I am directly exposed to sunlight (e.g. outdoor).	.028	-.263	.015	**.395**
46	During the day I am indirectly exposed to sunlight (e.g. through glass).	-.071	.265	-.126	**-.316**
47	I use sunscreen on my face.	-.072	-.265	.056	**-.300**

Table 3. Mean, standard deviation, percent floor and ceiling effects, and Cronbach's α for the vitamin D related knowledge, attitude and practice of this study (n = 572)

	n	Mean	Median	SD	Min	Max	Floor (%), ceiling (%)	Cronbach's a
General knowledge	11	79.59	81.81	14.52	4.55	100	2.4, 1.2	0.62
Nutrition knowledge	5	42.58	40.00	20.40	0.00	100	8.7, 0.00	0.60
Attitude	12	75.41	75.00	9.47	50.91	100	1.1, 0.00	0.68
Practice	10	58.69	58.00	8.60	32.00	94.00	0.00, 0.00	0.74

Table 4. Fit indices for measurement model of vitamin D KAP questionnaire based on 38 items

	χ^2	DF	χ^2/df	RMSEA	GFI	CFI	SRMSR	NFI	IFI
Model 1	1177.55	659	1.78	0.052	0.90	0.99	0.069	0.99	0.99
Model 2	1036.10	656	1.58	0.045	0.92	0.99	0.066	0.99	0.99

Model 1: Unmodified model

Model 2: Modified by adding covariances between items 44 and item 47, item 45 and item 47, and item 46 and item 47

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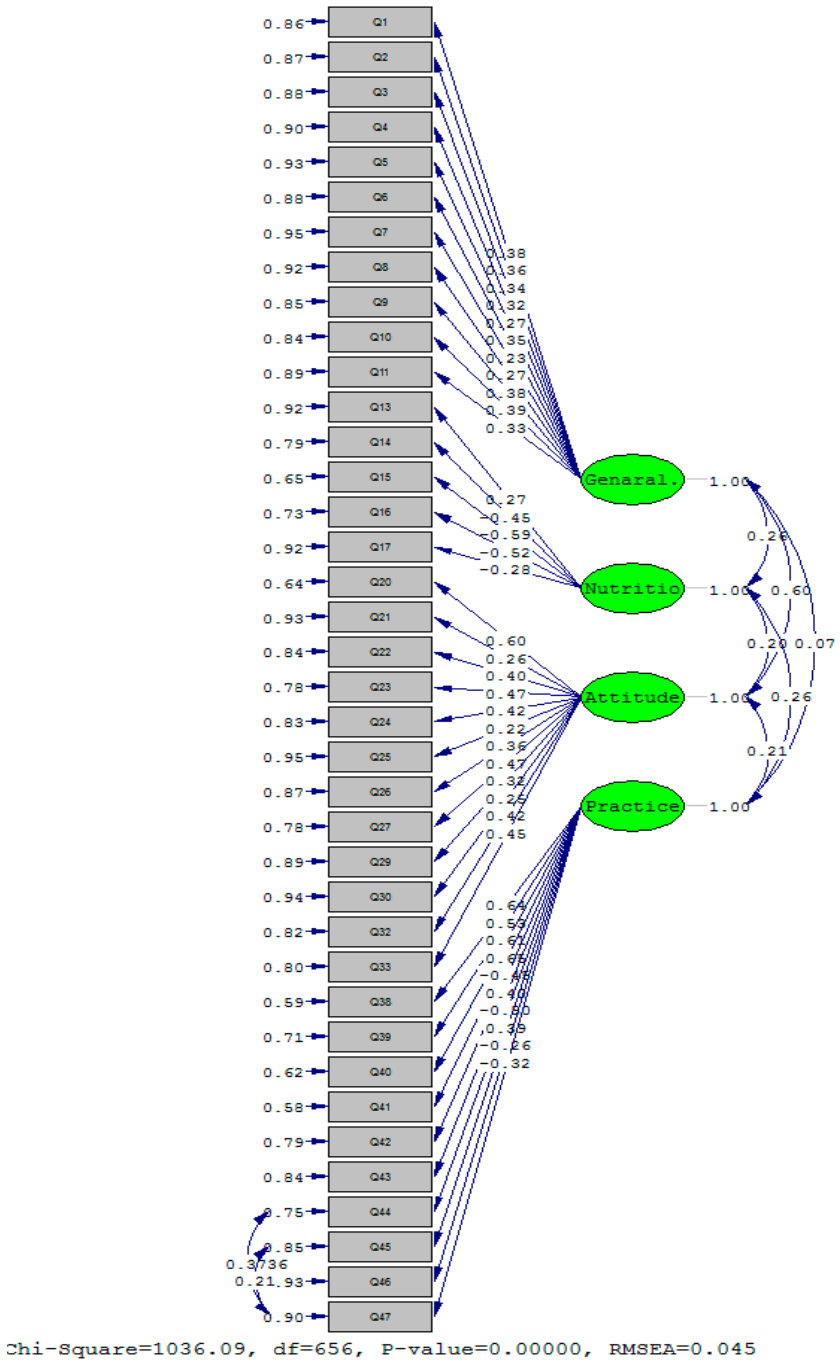

Figure 2. Standardized factor loadings of measurement model of vitamin D KAP questionnaire
Four latent constructs and 38 observed items were included in the CFA model. Based on the results of chi-square statistic and in order to achieve acceptable fit indices, the covariances of "q44, q47"=0.37 and "q45, q47"=0.21 have been added to model.

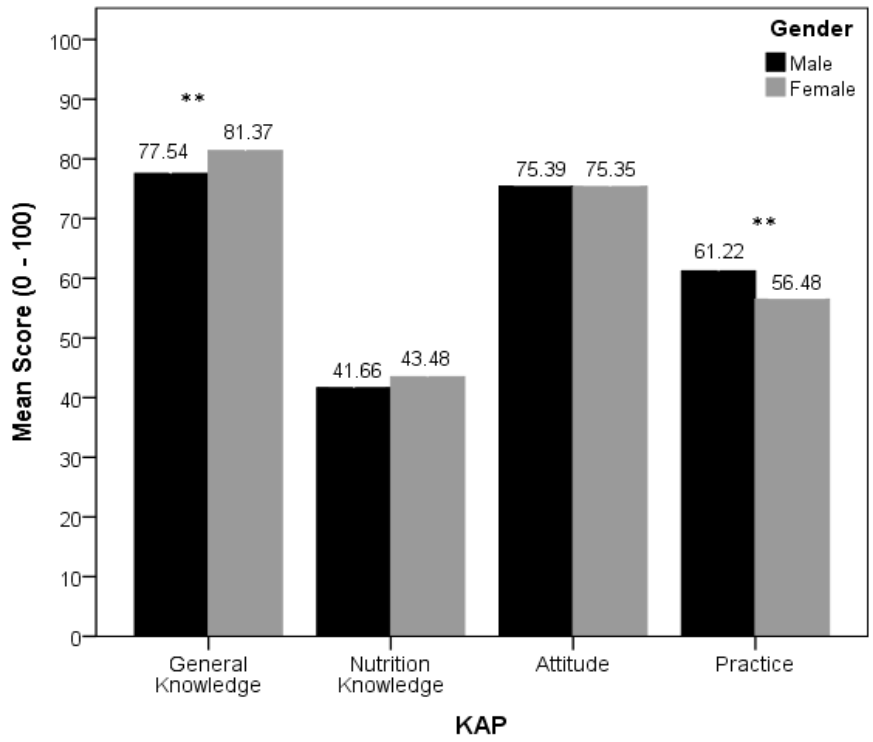

Figure 3. Mean comparison of KAP sub-scales between males and females (** p <0.01)

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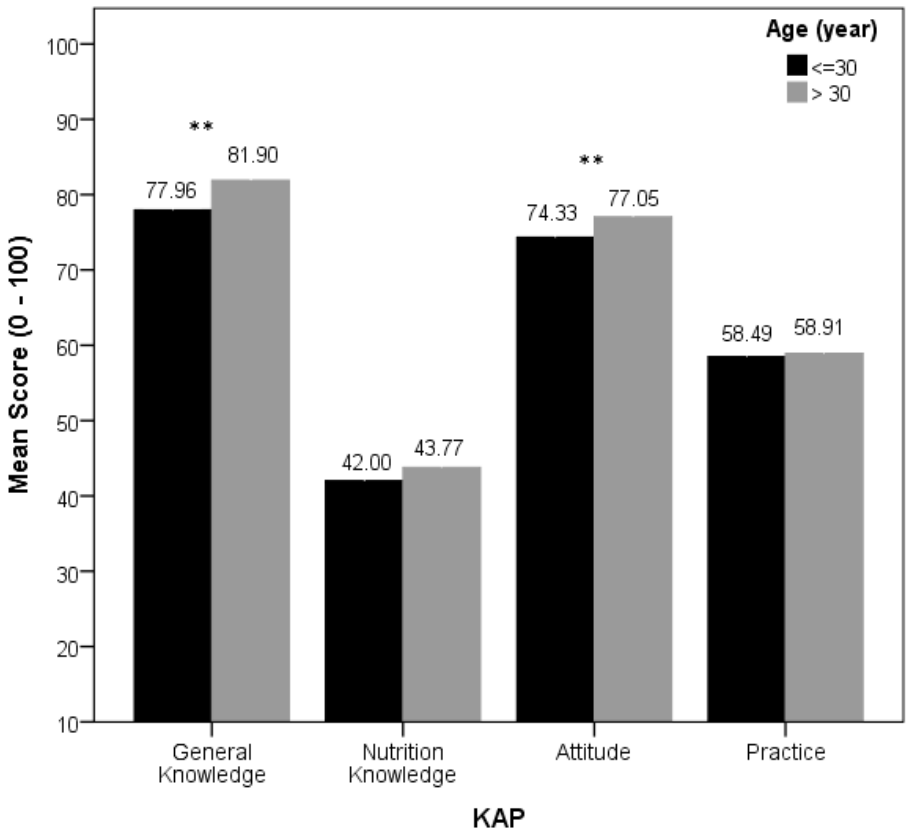

Figure 4. Mean comparison of KAP sub-scales between age groups (** $p < 0.01$)

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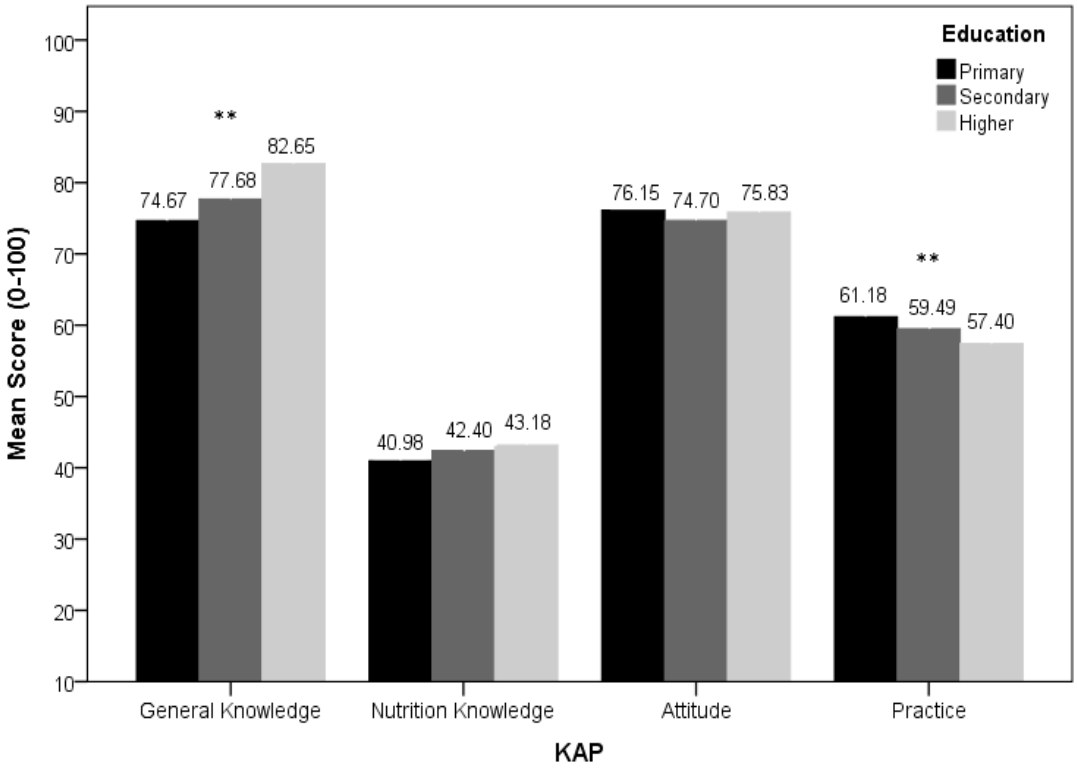

Figure 5. Mean comparison of KAP sub-scales between education groups (** $p < 0.01$)