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Vitamin D supplementation in young children: associations with Theory of Planned Behaviour variables, descriptive norms, moral norms and habits

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Abstract

Objective: In the Netherlands, a supplementation of 10 μg vitamin D is recommended for children (aged 0–4 years), given that vitamin D contributes to the development of healthy bones and deficiency during childhood is a risk factor for osteoporosis at a later age. However, only 60 % of the Dutch children receive sufficient vitamin D supplementation a day. In order to develop interventions to improve supplementation intake, it is necessary to gain insight into the behaviour of parents in giving their children vitamin D supplementation and its association with variables of the Theory of Planned Behaviour, moral and descriptive norms and habits.
Design: A cross-sectional survey to assess present supplementation-related behaviour, knowledge, received information, intention, attitude, subjective norm, perceived behavioural control, moral norm, descriptive norm and habit.
Setting: Data obtained from a representative Internet Panel by means of electronic questionnaires.
Subjects: Parents (*n* 270) of children aged 0–4 years.
Results: Half of the parents (48·9 %) gave their child sufficient vitamin D supplementation. Giving the supplement at a fixed time, a positive intention and habit were significantly associated with actual behaviour. The higher age of the child, first-born status, a fixed time for taking vitamin supplementation, descriptive norm and moral obligation were significantly associated with intention.
Conclusions: These results indicate that because many parents do not give their children adequate vitamin D supplementation, the promotion of supplementation during the first years of life is a necessity. Effective yet simple strategies should be developed, focused on improving moral obligation, descriptive norms and habit formation.

Keywords
Vitamin D supplementation
Children
Theory of Planned Behaviour
Habits

In the Netherlands, vitamin D supplementation is recommended for young children under the age of 4 years[1] given that vitamin D contributes to the development of healthy bones, and deficiency during childhood is a risk factor for osteoporosis at a later age[2–4]. Osteoporosis is a musculoskeletal disorder that can be attributed to low bone mass, resulting in bone fragility and an increased susceptibility to fractures[2]. Over 430 000 people have been diagnosed with osteoporosis in the Netherlands, mostly women over the age of 50 years, and an increase in prevalence is expected due to the rise in population in general and the ageing population in particular[5]. People with osteoporosis experience problems related to their physical condition (e.g. chronic pain, hip and wrist fractures, compressed vertebrae) that influence their quality of life, and can involve immobilization, fear, anxiety and depression[6]. The Dutch Osteoporosis Foundation[7] estimates the costs of treatment to be around €500 million annually, especially caused by hip fractures. These costs are expected to increase to €1 billion in 2025.

Vitamin D is found naturally in very few foods, and therefore added to margarine and infant formula. It is also synthesized by the skin when exposed to ultraviolet radiation from sunlight. An adequate intake for 0–4-year-old children is 10 μg/d in the form of drops or pills, depending on their exposure to sunlight, except for children using more than 500 ml of infant formula or follow-up formula, as these are fortified with vitamin D[1]. However, the mean intake for 2–6-year-old children varied from 1·8 to 2·1 μg/d[1], and many Dutch children receive insufficient supplementation: only about 60 % of children receive the recommended daily amount of vitamin D supplementation, and supplementation decreases as the child grows older[8,9]. Parents of young children are, in principle, informed about vitamin D supplementation by the Dutch child health-care organizations,

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which among other tasks monitor the growth and development of children aged 0–4 years and provide health education[1].

In order to develop interventions to improve vitamin D intake among young children, the reasons for (in)adequate intake should be identified. So far, little is known about why parents do or do not give their children vitamin D supplementation. To understand reasoned behaviours, the Theory of Planned Behaviour (TPB)[10] is often applied. This theory states that behaviour is influenced by the intention to perform that behaviour, and intention, in turn, is predicted by the individual's attitude towards the behaviour, the subjective norm and perceived behavioural control. Thus, in the case of vitamin D supplementation, parents with favourable attitudes towards vitamin D supplementation, a positive social norm and confidence in their own ability to apply the supplementation guidelines are more likely to develop positive intentions towards the actual performance of the behaviour. In a review of studies using the TPB for different health behaviours, TPB factors were found to explain up to 39 % of the variance in behaviour[11].

Other factors that may contribute to the performance of (or intention to perform) a behaviour, and that will be included in the present study, are moral norms[12], descriptive norms[13] and habits[14]. Moral norms refer to the individual's perception of the moral correctness or incorrectness of performing a behaviour, and reflect strong personal feelings about what one ought to do[12]. Descriptive norms reflect significant attitudes and behaviours of others, and account for 5 % of the explained variance in intention in addition to the TPB variables for various health behaviours, including healthy eating and physical exercise[13]. Habits are automatic responses to specific cues and are goal directed[14]. Such automatic processes – e.g. taking vitamin supplementation every morning when having breakfast – are not based on rational decision making; therefore, habits and intention have been found to have independent associations with actual behaviour[14].

To our knowledge, no studies apply Ajzen's TPB[10], moral norms, descriptive norms and habits to the provision of vitamin D supplementation to 0–4-year-old children by their parents in order to prevent osteoporosis. Therefore, the aim of the present study is to obtain insight into the behaviour of parents in giving their 0–4-year-old children vitamin D supplementation, and to identify factors that are related to this behaviour in order to provide recommendations on how to promote vitamin D supplementation.

Methods

Participants and procedures

In total, 500 parents were approached via Flycatcher (www.flycatcher.eu), an ISO-certified access panel with data from 20 000 people. The parents answered a questionnaire on the Internet pertaining to their youngest child under the age of 4 years, and were rewarded for their participation by way of Flycatcher's usual rewarding system. Parents who exclusively fed their children with infant formula were excluded from the study, since infant formula is already supplemented with 1·2–1·4 μg vitamin D per 100 ml prepared formula.

Instrument

The questionnaire was developed based on the TPB[10] and qualitative interviews with parents and pre-tested among ten parents before distribution. The first part contained questions about background variables: the child's sex and age, whether the child was the first born, the home situation (i.e. whether the child was living with a single parent), the child's diet (e.g. breast-fed, completely or partly formula-fed, eats what is cooked), the parent's present vitamin D supplementation behaviour, the parent's knowledge and whether the parent had ever received information about vitamin D supplementation. After these questions, the Health Council's advice on vitamin D supplementation was given to provide all participants with the same information and to enable participants to answer questions regarding intention, attitudes, subjective norms, perceived behavioural control, moral norms, descriptive norms and habits. These concepts were measured as suggested by the developers of the theories. Internal consistency (Cronbach's alpha) was reported if more items were used to measure a concept. The advice included explanation of why vitamin D is important in children and the amount of vitamin D that is required.

Present supplementation-related behaviour was assessed by seven questions on how many times per week the child received vitamin D supplementation, whether the child received the vitamin D supplementation at a fixed time, whether there were agreements about the supplementation within the family, how often the supplementation was forgotten, whether the child spent at least 15 min outside per day, and who gave the supplementation to the child. Adequate behaviour was defined as 'giving the child the daily recommended amount of vitamin D supplementation at least 6 d/week'.

Knowledge was determined by two items about why children need vitamin D, and what diseases are prevented by the intake of vitamin D.

Received information about vitamin D supplementation was explored by two questions: 'Have you ever received information about giving your child vitamin D supplementation every day?' – *yes/no*, and 'To what extent were you satisfied with the information you received?' – *very satisfied* (4) to *not satisfied* (0).

Intention to provide their children with vitamin D supplementation was determined with the question 'Do you intend to provide your child with the recommended daily intake in the next 2 weeks?' Answers were given on

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a 5-point Likert scale ranging from *yes, definitely* (+2) to *no, definitely not* (−2).

Attitude was assessed by six items for *direct attitude* (Cronbach's alpha = 0·57), such as 'I think giving the daily recommended amount of vitamin D to my child every day is important (healthy, useful, good, inconvenient, necessary)'. Answers were given on a 4-point scale ranging from *very important* (3) to *not important at all* (0). *Indirect attitude* was assessed with six items, including 'My child receives supplemental vitamin D because this is a good addition to his/her daily nourishment.' Answers were given on a 5-point Likert scale ranging from *totally agree* (+2) to *totally disagree* (−2).

Subjective norm was assessed with the beliefs of how significant others (the other parent, family members, friends, the general practitioner, the child health organization) felt about performing the behaviour ('Does your co-parent think your child needs to receive the daily recommended amount of vitamin D supplementation every day?'). Answers were given on a 5-point Likert scale ranging from *yes, definitely* (+2) to *no, definitely not* (−2), and were multiplied by the motivation to comply: 'How concerned are you about your co-parent's opinion about giving the daily recommended amount of vitamin D supplementation to your child every day?' Answers varied from *a lot* (5) to *not at all* (1).

Perceived behavioural control towards vitamin D supplementation was assessed by nine questions (Cronbach's alpha = 0·82), including 'Do you think you will manage to provide your child with the daily recommended amount of vitamin D supplementation every day?' Answers were given on a 5-point Likert scale ranging from *yes, definitely* (+2) to *no, definitely not* (−2).

Moral norm included three questions about the *responsibility* parents feel towards their child (Cronbach's alpha = 0·73). For instance, 'To what extent do you feel responsible for the health of your child?' Answers varied from *very responsible* (3) to *not responsible* (0). One question referred to whether the participants perceived an *obligation* to give their child vitamin D supplementation every day: *yes, definitely* (2) to *no, definitely not* (−2).

Descriptive norm was assessed by one question: 'How many parents in your surroundings give their children between 0 and 4 years the daily recommended amount of vitamin D supplementation every day?' Answers ranged from *(almost) nobody* (0) to *(almost) everybody* (5) and including a '*don't know*' option.

Habit in vitamin D supplementation was assessed by three questions of the Self-Report Habit Index[15]. These items included 'Giving the daily recommended amount of vitamin D supplementation to my child every day … is part of my and my partner's daily routine; is something that suits me and/or my co-parent; is something I and/or my co-parent have already done for a long time' (Cronbach's alpha = 0·85). Answers varied from *totally agree* (+2) to *totally disagree* (−2).

Statistical analyses

Descriptive statistics were used to describe the respondents, the TPB variables and the additional variables. To assess the explained variance of the TBP variables and additional variables in the present behaviour, stepwise logistic regression of adequate behaviour was undertaken. In step 1, the demographic variables were entered. In step 2, knowledge was entered, followed by the TPB variables attitude, subjective norm and perceived behavioural control in step 3. Intention was entered in step 4, and the additional variables moral norm and descriptive norm in step 5. Finally, the additional variable habit was entered in step 6.

To measure the influence of TPB variables and additional variables in intention, stepwise linear regression was performed on participants who do not give sufficient vitamin D supplementation (i.e. fewer than 6 d/week). In step 1, the demographic variables were entered, followed by knowledge in step 2. In step 3, the TPB variables attitude, subjective norm and perceived behavioural control were entered. The additional variables descriptive norm and moral norm were then entered in step 4.

All analyses were carried out using the Statistical Package for the Social Sciences statistical software package version 12.0 (SPSS Inc., Chicago, IL, USA).

Results

Response and participants

A total of 315 questionnaires were completed (response rate 63·0 %). Of these, forty-five children were exclusively fed with infant formula or follow-up infant formula, and were therefore excluded from the study. Of the remaining 270 participants, mostly mothers (73·3 %) completed the questionnaire, and most were of Dutch ethnicity (97·8 %). Altogether 16·6 % were highly educated, 62·2 % were educated to a medium level, and 21·1 % to a low level. Approximately half of the participants reported on a daughter (48·5 %), and for 46·3 % of the participants this was their first child; 18·9 % of the children were less than 1 year old, 35·6 % were 1 year, 34·8 % were 2 years and 10·7 % were 3 years. Almost all (99·3 %) of the children lived with the parent who completed the questionnaire, and almost all participants (94·8 %) reported that their children were in the open air for at least 15 min/d.

Supplement use and familiarity with the advice

Almost half (48·9 %) of the parents reported to have provided vitamin D supplementation to their children 6 or 7 d/week, while 29.6 % of parents never provided their children with vitamin D supplementation. In all, 6% of children received vitamin D supplementation on 5 d/week, 4·1 % on 4 d, 4·8 % on 3 d, 3·3 % on 2 d and 3·3 % on 1 d/week. Of the 215 participants, 79·6 % had positive

intentions towards supplementation, while 61·4% actually gave their child the recommended amount of vitamin D supplementation. Half of the participants (51·1%) reported having 'rules' about vitamin D supplementation intake every day. Most children (57·0%) received the supplementation at a fixed time, and 42·6% of the participants indicated that they sometimes forgot to provide the supplementation. The majority (70·7%) had received information about daily supplementation at some point, but of these 191 participants, 44·0% did not give their children vitamin D supplementation at least 6 d/week.

Associations between demographics, psychosocial variables, intention and behaviour

To explore correlates of actual behaviour, logistic regression analysis was performed. Table 1 shows that giving the supplement at a fixed time, having positive intentions and making it a habit were significantly associated with the chance that children were supplied with vitamin D. Giving the supplement at a fixed time had the highest odds ratios; Nagelkerke's R^2 was 0·582.

Linear regression analysis was undertaken to explore the correlates of intention of the respondents who did not give their children vitamin D supplementation (Table 2). The higher age of the child, first-born status (or otherwise), a fixed time for taking vitamin supplementation, descriptive norm and moral obligation explained 42·9% of the variance in intention. In the last model, moral obligation and descriptive norm added 13·9% of the variance.

Discussion

The aim of the present study was to assess actual vitamin D supplementation and its association with TPB variables, moral and descriptive norms and habits. Our results showed that only half of the parents involved in the study gave their children vitamin D supplementation at least 6 d/week. This was lower compared to the results from the Dutch Food Consumption Survey, which showed that 60% of the children aged 2–3 years received vitamin D supplementation on the two survey days[8], and the 57% of Dutch 1–4-year-olds who received vitamin D supplementation at least 5 d/week in another study[9]. Our study showed that among parents who were giving their children adequate vitamin D supplementation, having a fixed time to give the supplementation, moral obligation and descriptive norms were positively associated with the intention to provide the supplementation. These factors, as well as a positive intention towards vitamin D supplementation and habit, were associated with actual vitamin D supplementation. One could argue that having a fixed time to give a child the supplement partly overlaps with an individual's habit; for instance, when the supplementation are always given at the same time. Although both factors correlate ($r = 0{\cdot}397$, $P < 0{\cdot}01$), habit involves more than only repetition of the behaviour: it relies to a great extent on automatic responses to specific cues[14]. This automaticity was expressed in the items 'vitamin D supplementation is part of my daily routine' and '… is something I and/or my co-parent have already done for a long time'. Two other factors were associated with the desired behaviour, namely the age of the child (the older the child, the more likely it was that she/he received sufficient vitamin D) and whether the child was the first-born. This is likely due to the notion that when having their first child, parents tend to search for information about what is best for their child, whereas by the time they have subsequent children they feel confident enough about what to do. Although such factors like the age of the child and being the first-born cannot be changed, such information could be used to determine target groups for behaviour change interventions.

These results provide indications for targeting behavioural correlates, and have implications for the development of strategies that focus on habit formation and encourage positive intentions. Habits can be successfully established through the formation of implementation intentions[16]. Such intentions state when, where and how an individual should act on the intention to perform certain behaviour: for instance, 'I give my child vitamin pills when we have breakfast in the morning'. A fixed time to provide these vitamin pills is an essential part of an implementation intention. Forming implementation intentions could thus be a simple, applicable and effective technique that is worth exploring in motivating parents to give their children vitamin D supplementation. However, implementation intentions only work with motivated people[16]; thus, improving the strength of intention by strengthening the descriptive norm and moral obligation would be a useful strategy as a preparation for behaviour change, e.g. by creating models on how many parents give their children vitamin D supplementation, and counselling on moral norms[17].

These results, however, should not be interpreted without taking certain limitations into account. The first is methodological. We collected cross-sectional data, which allows only for the detection of associations between psychosocial factors and behaviour, although it would be more useful to detect causal relationships between these concepts. The second limitation is related to the sample of participants: participants of Dutch ethnicity and medium-to-high level educated people were over-represented in our study[18], which means that the results are limited to this group. Especially children of non-European mothers seem to get less vitamin D than is recommended[9], due to both a darker skin pigmentation that limits the conversion of vitamin D, and (in some cultures) the use of long sleeves and pants, and/or the use of oil (instead of fortified margarine). We thus recommend repeating the study among immigrant parents originally from Asia or Africa and people with a lower educational background.

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Table 1 Logistic regression analysis with giving the child adequate vitamin D supplementation as the dependent variable†

	Step 1		Step 2		Step 3		Step 4		Step 5		Step 6	
Included variables	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Demographic variables												
Child's sex	1·008		1·012		1·112		1·164		1·205		1·242	
Child's age	0·826		0·825		0·831		0·783		0·802		0·895	
First born	2·063	1·107, 3·846	2·057	1·101, 3·842	2·047	1·057, 3·966	1·868		1·818		1·957	
Parent's sex	1·033		1·041		1·075		1·005		1·011		0·930	
Parent's education level	0·795		0·796		0·873		0·859		0·861		0·865	
Fixed time	12·806	5·984, 27·403	12·923	5·931, 28·154	11·919	5·125, 27·717	10·536	4·436, 25·024	9·755	4·062, 23·424	7·387	3·001, 18·181
Child asks for vitamin D	1·050		1·050		1·050		1·053		1·046		1·048	
Rules regarding vitamin D	1·549		1·544		1·385		1·379		1·375		1·305	
Information received	1·679		1·691		1·836		1·979		2·043		1·829	
Knowledge			0·992		0·964		0·955		0·948		0·952	
TPB variables												
Direct attitude					0·194		0·175		0·248		0·225	
Indirect attitude					1·800		1·324		1·408		1·204	
Subjective norm					1·205		1·173		1·117		1·119	
Perceived behavioural control					1·248		1·287		1·291		1·251	
Intention							1·876	1·102, 3·194	1·943	1·085, 3·477	1·892	1·027, 3·484
Descriptive norm									1·131		1·126	
Moral responsibility									0·320		0·314	
Moral obligation									1·009		0·936	
Habit											1·888	1·139, 3·129
Nagelkerke R^2	0·447		0·447		0·519		0·538		0·554		0·582	

TPB, Theory of Planned Behaviour.
†95 % CI is only reported if significant at $P < 0·05$.

Table 2 Results of regression analysis with intention to give vitamin D supplementation as the dependent variable

	Model 1 β coefficient	Model 2 β coefficient	Model 3 β coefficient	Model 4 β coefficient
Demographic variables				
Child's sex	−0·078	−0·090	−0·052	−0·025
Child's age	0·303**	0·316**	0·268**	0·178*
First born	0·188*	0·184*	0·190*	0·156*
Parent's sex	0·100	0·082	0·091	0·056
Parent's education level	0·034	0·019	0·026	0·011
Fixed time	0·285***	0·276**	0·249*	0·233*
Child asks for vitamin D	0·105	0·113	0·066	0·016
Rules regarding vitamin D	0·097	0·096	0·062	−0·001
Information received	−0·183*	−0·204*	−0·167	−0·114
Knowledge		0·082	0·076	0·069
TPB variables				
Direct attitude			−0·050	−0·127
Indirect attitude			0·208*	0·107
Subjective norm			0·092	0·058
Perceived behavioural control			−0·045	−0·075
Descriptive norm				0·195*
Moral responsibility				0·097
Moral obligation				0·312***
Variance explained (R^2)	0·239	0·245	0·290	0·429

TPB, Theory of Planned Behaviour.
*$P<0·05$, **$P<0·01$, ***$P<0·001$.

Furthermore, we did not measure the child's response on vitamin D supplementation in the form of drops or pills. This could be an important determinant of adherence to vitamin D intake and should be included in future studies.

For the promotion of vitamin D supplement use, concomitant issues should be taken into account. Adequate vitamin D levels could also be obtained by using infant formula and through exposure to sunlight[19]. However, breast-feeding only and ensuring sun protection are behaviours that are actively promoted by public health organizations for infants younger than 6 months and young children. Yet both are incompatible with the recommendations for adequate vitamin D intake, and giving breastfed infants vitamin D drops is a relatively complicated procedure. Vitamin D is already added to infant formula but if you only give your child breast-feeding you have to give him/her the drops at another moment. Therefore, we advocate easy-to-implement strategies to enhance the chance of adequate vitamin D intake. Such strategies could be the aforementioned implementation intentions, which appeared to be successful in motivating parents to use adequate sun protection for their child[20], or cues/reminders – such as magnets – that serve as reminders for parents to give their children vitamin D. Using child health-care nurses could be a good opportunity to disseminate such strategies, as health education is part of their usual care.

On the basis of the present study, we conclude that because many parents do not give their children adequate vitamin D supplementation, the promotion of adequate vitamin D supplementation during the first years of life is a necessity. Supplementation can be provided in the form of drops or pills, depending on the parent's and child's preference. Effective yet simple strategies should be developed for this, focused on improving moral obligation, descriptive norms and habit formation.

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