

# Vitamin D status of refugees arriving in Canada

## Findings from the Calgary Refugee Health Program

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### Abstract

**Objective** To determine the 25-hydroxyvitamin D (25[OH]D) serum levels in refugee women of childbearing age and in refugee children; to compare their 25(OH)D levels with the recommended levels in order to determine the prevalence of deficiency; to compare their 25(OH)D levels with those in the general Canadian population in the appropriate age and sex groups; and to investigate the association of vitamin D deficiency with potential risk factors.

**Design** Cross-sectional chart review.

**Setting** The Calgary Refugee Health Program, an urban family practice that serves newly arrived refugees in Calgary, Alta.

**Participants** A total of 1217 refugee women and children screened between June 2005 and January 2010.

**Main outcome measures** Serum 25(OH)D values that were measured during initial screening visits.

**Results** Overall, 1217 of the 1768 eligible participants (69%) had 25(OH)D laboratory values recorded. The mean concentration of 25(OH)D was 52.0 nmol/L (95% CI 50.6 to 53.3 nmol/L). Using the Institute of Medicine guideline for adequate serum vitamin D levels (>50 nmol/L), 61% of women and 42% of children had lower-than-desirable 25(OH)D levels. Considering the Osteoporosis Canada guidelines, 88% of women and 81% of children had lower-than-desirable 25(OH)D levels (<75 nmol/L), and 21% of women and 10% of children were vitamin D deficient (<25 nmol/L). Mean levels of 25(OH)D were significantly lower across all age and sex groupings compared with the general Canadian population ( $P<.001$ ). Women from the Middle East had lower mean 25(OH)D values (24.6 nmol/L, 95% CI 21.7 to 27.5 nmol/L) compared with women from Asia, Africa, or South America ( $P<.001$ ). Mean values of 25(OH)D were lower during the winter in children ( $P=.01$ ) but not in women. Female refugees between the ages of 12 and 19 years old had lower mean values of 25(OH)D than male refugees in the same age group did ( $P=.01$ ).

**Conclusion** Most refugees had lower-than-desirable vitamin D levels. All age groups studied had lower mean 25(OH)D levels compared with the general Canadian population. Health care providers should be aware of this concern and consider vitamin D supplementation among refugees.

### EDITOR'S KEY POINTS

- This study examined the vitamin D levels of newly arrived refugee women of childbearing age and refugee children at the Calgary Refugee Health Program in Alberta.
- Most of the participants in the study had lower-than-desirable vitamin D levels. These levels were considerably lower across all age and sex groupings compared with the general Canadian population, and were particularly low among women from the Middle East.
- Refugees are at high risk of vitamin D deficiency, and health care providers should be aware of this concern and consider vitamin D supplementation for such patients.

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# État des réfugiés arrivant au Canada sur le plan des carences en vitamine D

## Constataions du Refugee Health Program de Calgary

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### Résumé

**Objectif** Déterminer les taux sériques de 25-hydroxyvitamine D (25[OH]D) chez des femmes en âge de procréer et des enfants réfugiés pour comparer leurs taux de 25(OH)D avec les taux recommandés pour cerner la prévalence des carences; comparer leurs taux de 25(OH)D avec ceux dans la population canadienne en général selon les groupes d'âge et le sexe appropriés; et examiner l'association des carences en vitamine D avec les facteurs de risque potentiels.

**Conception** Étude transversale des dossiers.

**Contexte** Le Refugee Health Program de Calgary, une pratique familiale urbaine qui dessert les réfugiés nouvellement arrivés à Calgary, en Alberta.

**Participants** Un total de 1 217 femmes et enfants réfugiés ayant subi un dépistage entre juin 2005 et janvier 2010.

**Principaux paramètres à l'étude** Les valeurs sériques de 25(OH)D telles que mesurées lors des visites initiales de dépistage.

**Résultats** Dans l'ensemble, les valeurs de 25(OH)D mesurées en laboratoire de 1 217 des 1 768 participants admissibles (69 %) avaient été consignées. La concentration moyenne de 25(OH)D était de 52,0 nmol/l (IC à 95 % de 50,6 à 53,3 nmol/l). En se fondant sur les lignes directrices de l'Institute of Medicine concernant les taux sériques de vitamine D acceptables, (>50 nmol/l), 61 % des femmes et 42 % des enfants avaient des taux de 25(OH)D plus bas que souhaitables. Selon les lignes directrices d'Ostéoporose Canada, 88 % des femmes et 81 % des enfants avaient des taux de 25(OH)D plus faibles que ceux considérés acceptables (<75 nmol/l), et 21 % des femmes et 10 % des enfants souffraient de carences en vitamine D (<25 nmol/l). Les taux moyens de 25(OH)D étaient considérablement plus faibles dans tous les groupes d'âges et selon le sexe par rapport à ceux dans la population canadienne en général ( $P < ,001$ ). Les femmes en provenance du Moyen-Orient avaient des valeurs moyennes de 25(OH)D plus basses (24,6 nmol/l, IC à 95 % de 21,7 à 27,5 nmol/l) par rapport à celles venant d'Asie, d'Afrique ou d'Amérique du Sud ( $P < ,001$ ). Les valeurs moyennes de 25(OH)D étaient moins élevées durant l'hiver chez les enfants ( $P = ,01$ ) mais pas chez les femmes. Les femmes réfugiées de 12 à 19 ans avaient des valeurs moyennes plus faibles de 25(OH)D que les hommes réfugiés du même groupe d'âges ( $P = ,01$ ).

**Conclusion** La plupart des réfugiés avaient des taux de vitamine D plus faibles que souhaitables. Dans tous les groupes d'âges à l'étude, les taux moyens de 25(OH)D étaient inférieurs en comparaison de ceux dans la population canadienne en général. Les professionnels de la santé devraient être au fait de cette préoccupation et envisager de recommander des suppléments de vitamine D aux patients réfugiés.

#### POINTS DE REPÈRE DU RÉDACTEUR

- Cette étude examinait les taux de vitamine D chez des femmes réfugiées en âge de procréer et chez des enfants réfugiés dans le cadre du Refugee Health Program de Calgary en Alberta.
- La plupart des sujets à l'étude avaient des taux de vitamine D plus faibles que souhaitables. Ces taux étaient considérablement plus bas dans tous les groupes d'âges et selon le sexe par rapport à ceux dans la population canadienne en général et ils étaient particulièrement moins élevés chez les femmes du Moyen-Orient.
- Les réfugiés courent un risque élevé de souffrir de carences en vitamine D et les professionnels de la santé devraient être au courant de cette préoccupation et envisager de recommander des suppléments de vitamine D à de tels patients.

Cet article a fait l'objet d'une révision par des pairs.  
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Vitamin D has an established role in skeletal health.<sup>1</sup> Some also suggest that vitamin D is associated with immune function, cardiovascular health, neuromuscular function, and cancer prevention.<sup>2</sup> In pregnancy, vitamin D deficiency has been associated with adverse outcomes, including gestational diabetes,<sup>3</sup> preeclampsia,<sup>4</sup> and low birth weight.<sup>5</sup>

Some immigrants arriving to the Western world are predisposed to vitamin D deficiency owing to a variety of factors. Cultural and religious practices that limit skin exposure to the sun, such as extensive clothing and limited time outside, might result in deficiency,<sup>6-9</sup> while people with darker skin pigmentation produce vitamin D with reduced efficiency compared with lighter-skinned individuals.<sup>10</sup> Also, people of lower socioeconomic status are at risk of vitamin D deficiency,<sup>11</sup> and newly arrived immigrants are more likely to live in low-income families.<sup>12</sup> There is little research examining the vitamin D status of immigrants to Canada, and there is no known published literature that specifically examines the vitamin D levels in Canadian refugees who represent a vulnerable population at risk of rapidly declining health.<sup>13</sup> Establishing the vitamin D levels of Canadian refugees will create awareness among health care practitioners, and it is an important step to ensuring that deficiency among patients is identified and treated.

A pilot study was conducted at the Calgary Refugee Health Program in Alberta in 2005. The study reviewed 400 charts from all newly registered patients between July 2003 and August 2005, of which 26 had vitamin D levels recorded. The study found that 92% (24 of 26) of the patients were vitamin D deficient based on the Calgary Laboratory Services cutoff (<80 nmol/L).<sup>14</sup> Since that time, the clinic has routinely ordered measurement of 25-hydroxyvitamin D (25[OH]D) levels as part of its screening program for women of childbearing age and for children.

The objectives of the current study were to determine the 25(OH)D serum levels in refugee women of childbearing age and refugee children from the Calgary Refugee Health Program, compare their 25(OH)D serum levels to the recommended levels to determine the prevalence of deficiency, compare their 25(OH)D serum levels with those in the general Canadian population in the appropriate age and sex groups, and investigate the association of vitamin D deficiency with potential risk factors.

## METHODS

### Participants

The Conjoint Health Research Ethics Board of the University of Calgary granted ethics approval for the current study.

The Calgary Refugee Health Program serves government-assisted refugees, refugee claimants, and privately sponsored refugees arriving to Calgary. A complete medical history is taken, and patients receive physical examination and laboratory testing appropriate to their health concerns and region of origin. The program aims to screen refugees within weeks of their arrival to Calgary and cares for patients up to 2 years after their arrival.

All charts were searched electronically between June 2005 and January 2010. Data abstracted from each chart were age, sex, country of origin, and 25(OH)D level and the date it was measured. All men older than 19 years of age and women older than 45 years of age were excluded because they were not routinely screened at the clinic. There was no cutoff for minimum age. Only the earliest recorded 25(OH)D value was included for each patient.

### The 25(OH)D assay

The best indicator of overall vitamin D status is the circulating serum level of 25(OH)D.<sup>15</sup> All samples were analyzed at the Calgary Laboratory Services Diagnostic and Scientific Centre, which has used the industry standard DiaSorin Liaison 25(OH)D vitamin D assay since 2007. Before 2007, the laboratory used a DiaSorin 25(OH)D RIA assay. The 2 methods were equivalent as demonstrated in a head-to-head trial (regression equation: Liaison=0.99 (RIA) +2.4,  $r=0.97$ ).<sup>16</sup>

### Statistical analysis

Data were analyzed using Microsoft Excel and SPSS software. Mean 25(OH)D values were compared based on age, sex, region of origin, and season of collection. Data were compared with the mean vitamin D levels of Canadians as measured by the Canadian Health Measures Survey, which also used the DiaSorin Liaison 25(OH)D assay.<sup>17</sup> For comparison with that study, the same age groups were defined (6 to 11 years of age, 12 to 19 years of age, and 20 to 39 years of age) and *t* tests were used to make comparisons for the appropriate age and sex groups. The current study included children younger than 6 years of age and women aged 40 to 45 who represented a subgroup of the 40-to-59-year age group reported in that study. Mean 25(OH)D values were compared by refugees' region of origin using 1-way ANOVA (analysis of variance) and Tukey post-hoc tests. The distribution of 25(OH)D values was also determined for each region.

In 2010, the Institute of Medicine (IOM) suggested that a 25(OH)D level of 50 nmol/L was associated with health benefits for most of the population.<sup>18</sup> This recommendation remains controversial<sup>19</sup> and some suggest an optimum level is above 75 nmol/L.<sup>17,20-22</sup> In this study, data were analyzed with respect to the IOM's suggestions. Serum 25(OH)D levels were also

categorized as desirable (>75 nmol/L), insufficient (25 to 75 nmol/L), and deficient (<25 nmol/L), as per the Osteoporosis Canada guidelines.<sup>1</sup>

RESULTS

Participants

We reviewed a total of 2688 charts, of which 920 were excluded because they did not meet age and sex criteria. Of the remaining 1768 charts, 1217 (69%) had 25(OH)D laboratory values recorded and were included in the final analysis. These comprised 461 of the 652 women aged 20 to 45 (71%), and 756 of the 1116 children aged 0 to 19 (68%). The refugees came from 35 countries representing 4 main geographic regions (Table 1). The small subgroups of participants from Mexico and the Caribbean (n=43) and Eastern Europe (n=13) were included in the main analysis but excluded from subgroup analysis.

Mean 25(OH)D values

The mean 25(OH)D level among all refugees was 52.0 nmol/L (95% CI 50.6 to 53.3 nmol/L). The mean 25(OH)D value among the women was 46.2 nmol/L (95% CI 44.1 to 48.3 nmol/L), and among children it was 55.5 nmol/L (95% CI 53.8 to 57.2 nmol/L). Compared with the Canadian population, participants had significantly lower mean 25(OH)D values across all age and sex groupings (P<.001) (Figure 1).<sup>17</sup>

Using the IOM guideline (25[OH]D level >50 nmol/L representing sufficient vitamin D), 61% of women and 42% of children had lower-than-desirable levels (Table 2). Considering the Osteoporosis Canada guidelines for 25(OH)D levels, 88% of women and 81% of children had lower-than-optimal 25(OH)D levels (<75 nmol/L), and 21% of women and 10% of children were vitamin D deficient (<25 nmol/L) (Table 2).

Age and sex

The highest 25(OH)D mean levels were in children aged 0 to 5 years (61.5 nmol/L, 95% CI 57.9 to 65.1 nmol/L) and the lowest were in women aged 20 to 39 (45.6 nmol/L, 95% CI 43.4 to 47.9 nmol/L). Mean 25(OH)D values for

male and female refugee children were similar, except for the 12- to 19-year-old age group, in which female refugees had lower mean values (46.4 vs 52.4 nmol/L, P=.01) (Figure 1, Figure 2).

Region of origin

Women from the Middle East had a mean 25(OH)D concentration of 24.6 nmol/L (95% CI 21.7 to 27.5 nmol/L), which was lower than the mean 25(OH)D values of women from all other regions (P<.001) (Figure 3). Ninety-eight percent of women from the Middle East had serum 25(OH)D levels of less than 50 nmol/L (Table 2). Similarly, the lowest mean values in children were in children from the Middle East (42.1 nmol/L, 95% CI 35.1 to 49.1 nmol/L), 73% of whom had values lower than 50 nmol/L (Figure 4). Mean 25(OH)D levels in children from the Middle East were significantly lower than in those from Africa (P=.002) and South America (P<.001).

Figure 1. Mean 25(OH)D values of refugees and the Canadian population, by age and sex groupings: Error bars represent 95% CIs.

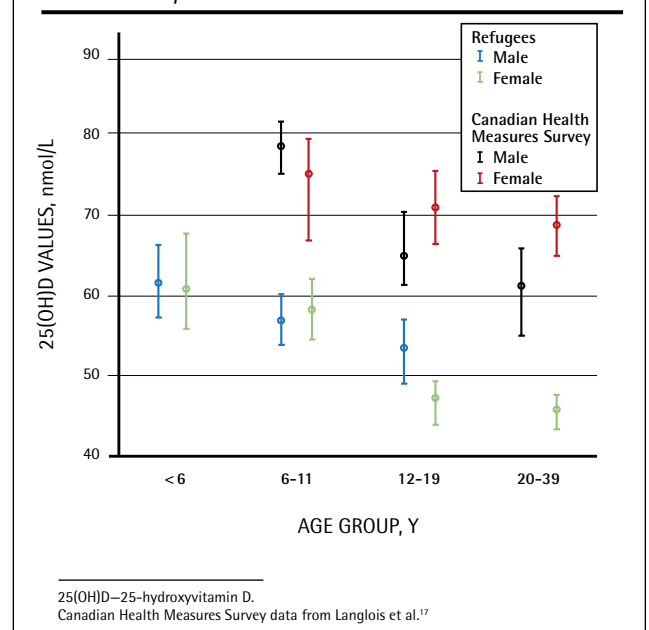


Table 1. Refugees' region of origin, by age group: N = 1217.

AGE GROUP, Y	REGION OF ORIGIN, N (%)*					TOTAL (N = 1217)
	AFRICA (N = 412)	ASIA (N = 334)	MIDDLE EAST (N = 106)	SOUTH AMERICA (N = 309)	OTHER (N = 56)	
0-5	73 (18)	71 (21)	21 (20)	53 (17)	10 (18)	228 (19)
6-11	73 (18)	68 (20)	20 (19)	66 (21)	16 (29)	243 (20)
12-19	90 (22)	79 (24)	18 (17)	92 (30)	6 (11)	285 (23)
20-39	156 (38)	110 (33)	38 (36)	81 (26)	19 (34)	404 (33)
40-45	20 (5)	6 (2)	9 (8)	17 (6)	5 (9)	57 (5)

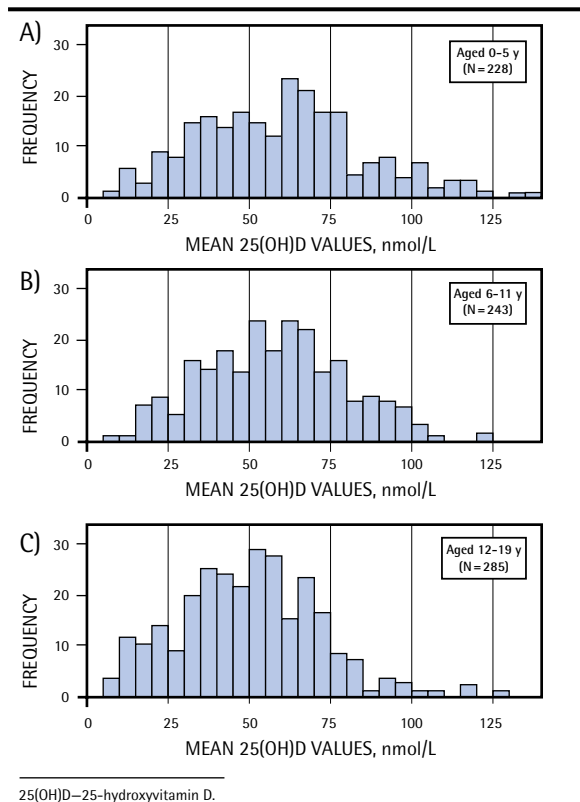
\*Some percentages do not add to 100% owing to rounding.

**Table 2. Refugees whose vitamin D plasma concentration levels met and did not meet those recommended by the IOM and Osteoporosis Canada guidelines**

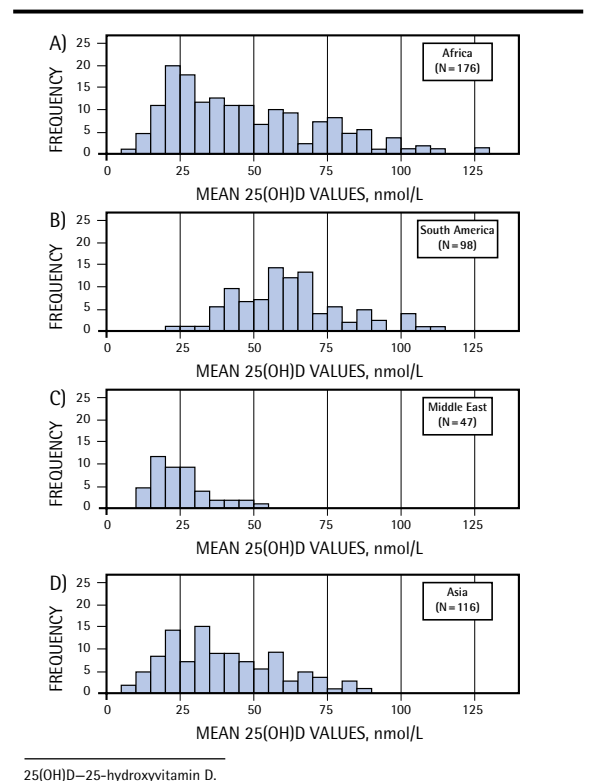
REFUGEES	VITAMIN D PLASMA CONCENTRATION RECOMMENDATIONS			
	IOM GUIDELINES, LOWER THAN DESIRABLE (<50 nmol/L), N (%)	OSTEOPOROSIS CANADA GUIDELINES		
		DEFICIENT (<25 nmol/L), N (%)	INSUFFICIENT (25–75 nmol/L), N (%)	DESIRABLE (>75 nmol/L), N (%)
<b>Children, 0–19 y</b>				
All children (N = 756)	318 (42)	78 (10)	539 (71)	139 (18)
Region of origin				
• Africa (n = 236)	112 (47)	34 (14)	148 (63)	54 (23)
• Asia (n = 218)	105 (48)	27 (12)	170 (78)	21 (10)
• Middle East (n = 59)	43 (73)	15 (25)	40 (68)	4 (7)
• South America (n = 211)	48 (23)	2 (1)	155 (73)	54 (26)
• Other (n = 32)	10 (31)	0 (0)	26 (81)	6 (19)
<b>Women, 20–45 y</b>				
All women (N = 461)	279 (61)	96 (21)	309 (67)	56 (12)
Region of origin				
• Africa (n = 176)	109 (62)	39 (22)	109 (62)	28 (16)
• Asia (n = 116)	82 (71)	29 (25)	81 (70)	6 (5)
• Middle East (n = 47)	46 (98)	27 (57)	20 (43)	0 (0)
• South America (n = 98)	26 (27)	1 (1)	78 (80)	19 (19)
• Other (n = 24)	16 (67)	0 (0)	21 (88)	3 (12)

IOM—Institute of Medicine.

**Figure 2. Mean 25(OH)D values of refugee children, by age group: A) Children aged 0–5, B) children aged 6–11, and C) children aged 12–19.**

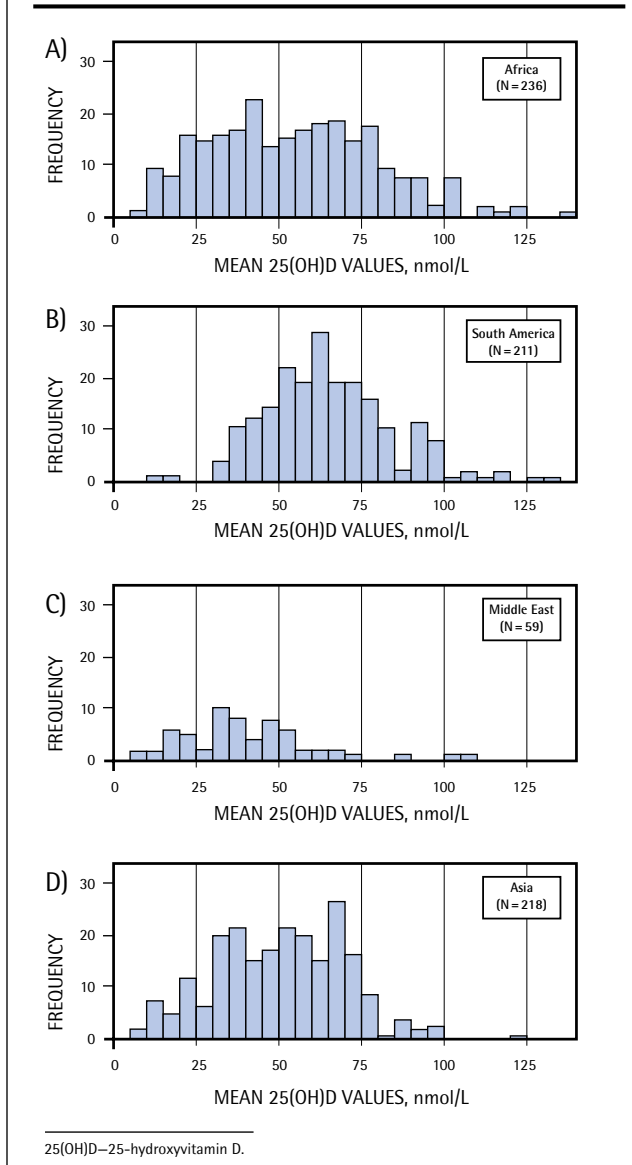


**Figure 3. Mean 25(OH)D values of refugee women, by region of origin: A) Women from Africa, B) women from South America, C) women from the Middle East, and D) women from Asia.**





**Figure 4. Mean 25(OH)D values of refugee children, by region of origin: A) Children from Africa, B) children from South America, C) children from the Middle East, and D) children from Asia.**



### Seasonal variation

We found a significant seasonal variation among children ( $P=.01$ ), with lower mean 25(OH)D values being recorded from November to March (52.4 nmol/L, 95% CI 49.4 to 55.4 nmol/L) and higher mean 25(OH)D values from April to October (57.4 nmol/L, 95% CI 55.4 to 59.4 nmol/L). However, there was no significant ( $P=.65$ ) seasonal variation in women's mean 25(OH)D values (mean 25(OH)D value from November to March was 45.6 nmol/L, 95% CI 42.0 to 49.1 nmol/L; mean 25(OH)D value from April to October was 46.6 nmol/L, 95% CI 44.0 to 49.2 nmol/L).

### DISCUSSION

Most refugees studied had lower-than-desirable vitamin D levels when categorized based on IOM and Osteoporosis Canada guidelines. When compared with the Canadian population, refugees had lower levels across all age and sex categories. Women and children from the Middle East had the lowest mean 25(OH)D levels compared with all other regions. These findings suggest that refugee women of childbearing age and children newly arrived to Calgary are at high risk of being vitamin D deficient, and therefore are at risk of the health concerns associated with vitamin D deficiency.

Well-defined risk factors such as cultural clothing practices and darker skin pigmentation among the participants likely contributed to the observed findings. In addition, the challenging economic circumstances faced by refugees before their arrival in Canada might also have contributed to the high prevalence of deficiency.

Our results are consistent with previous studies showing vitamin D deficiency among immigrants moving to a higher latitude.<sup>9,23,24</sup> Our results also have important implications given that previous studies indicate that vitamin D deficiency worsens with increasing time since arrival.<sup>9</sup> Because many of the refugees moved to Calgary's northern latitude of 51° from more equatorial latitudes, it is plausible that the low levels of vitamin D in the current study would be exacerbated with time.

Our finding of lower 25(OH)D concentration with increasing age, with women having lower values than children, is consistent with data reported for the Canadian population.<sup>17</sup> This finding is particularly relevant given that low 25(OH)D levels have been associated with adverse outcomes in pregnancy.<sup>3-5</sup>

We found that refugees from the Middle East had lower mean 25(OH)D levels than any other regional group. When data were analyzed by individual country, it was found that North Africans had mean 25(OH)D values similar to those of participants from the Middle East, and significantly lower than those of sub-Saharan Africans ( $P<.001$ ). Participants from Western Asia had significantly lower mean values than those from East Asia ( $P<.001$ ) (data not shown). This suggests that sociocultural clothing practices in predominantly Muslim countries likely contributed to low levels of vitamin D; these findings are in keeping with those of other authors.<sup>7</sup>

The lack of seasonal variation among women might be a result of the participants having recently arrived and not having equilibrated to Canadian seasonal trends. It takes 3 months for 25(OH)D levels to reach a steady state after a dose adjustment.<sup>14</sup>

## Limitations

The results of our study should be interpreted in light of the study limitations. First, of the eligible participants, 69% had laboratory values recorded. In our experience, the main barriers preventing refugees from presenting for specimen collection include unawareness of the necessity of laboratory investigations and lack of systematic follow-up to identify those who did not present. These factors do not appear to be associated with vitamin D status, so it seems unlikely that failure to present created a selection bias.

Second, we did not measure dietary vitamin D intake or exposure to sunlight. This would have been difficult based on the retrospective nature of this study and the dispersed residences of newly arrived refugees.

Third, time since arrival in Canada was not included in the analysis; however, the mandate of the clinic was to screen refugees as soon as possible after their arrival to Canada. This usually takes place within weeks and therefore is unlikely to be a confounder.

Finally, these results cannot necessarily be generalized to other immigrant groups, as refugees likely face socioeconomic barriers that affect their vitamin D status.

## Conclusion

Based on a screening program, we found that most of the newly arrived refugees in Calgary had lower-than-desirable vitamin D levels. These levels were significantly lower across all age and sex groupings compared with the Canadian population. Refugees are at high risk of being vitamin D deficient; health care providers should be aware of this concern and consider vitamin D supplementation in such patients. Further research is needed to characterize deficiency among refugees over the time period following their arrival, as well as to define best practices for replacement therapy and to identify barriers for refugees to achieve adequate vitamin D levels.

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### Contributors

**Dr Aucoin** planned and conducted the research, as well as designed the research approach, completed the literature review, acquired the data, and wrote most of the article. **Mr Weaver** conducted and helped to plan the analysis of data; subsequently, he was also involved in extending the literature review and revising the manuscript. **Dr Thomas** provided important direction for the data analysis and presentation of the manuscript. **Dr Jones** was involved in the overall conception of the project and also contributed to revision of the manuscript.

### Competing interests

None declared

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