VITAMIN D SUPPLEMENTATION IMPROVES MOOD OVER WINTER IN NEW ZEALAND OFFICE WORKERS

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INTRODUCTION

New Zealand's Ministry of Health (MOH) states that 5% of New Zealanders are vitamin D deficient and a further 27% fall below the recommended blood level of vitamin D. Vitamin D deficiency is associated with rickets in children and bone weakness in adults. Research has also linked vitamin D deficiency to a multitude of health and wellness issues such as mental health, cancer and cardiovascular disease (Murphy & Wagner, 2008). Research on maintaining adequate vitamin D levels has shown that it reduces the risk from diabetes mellitus, rheumatoid arthritis, multiple sclerosis and other autoimmune diseases (Murphy & Wagner, 2008). Symptoms of vitamin D deficiency include excessive sleep, daytime drowsiness, reduced concentration, carbohydrate craving, weight gain, increased appetite, reduced energy, aching bones, headaches, gastrointestinal issues and depression (Mercola, 2014).

Aspects of vitamin D deficiency can interrupt people achieving all the dimension of wellness; mood disorders, such as seasonal affective disorder (SAD), linked to vitamin D deficiency impact on emotional health. When SAD affects individuals, they may experience inappropriate feelings of worthlessness or guilt (Murphy & Wagner, 2008). Additionally, SAD affects interpersonal wellbeing, as individuals can lose their enjoyment of everyday activities (Murphy & Wagner, 2008; Fahey, Insel & Roth, 2009). The Mental Health Foundation New Zealand notes that people with SAD may withdraw from others. Interpersonal health includes maintaining relationships that are supportive and satisfying, along with participation within society and the community (Peters, 2014). Intellectual wellness is linked with challenging the mind and with learning. However, vitamin D deficiency and SAD may interrupt this process, as both have been related to memory loss and poor concentration (Murphy & Wagner, 2008; Statistics New Zealand, 2017).

Vitamin D is essentially a hormone, as it is synthesised on the skin through UVB rays. While vitamin D can be found minimally in food, the sun provides the predominate source (Murphy & Wagner, 2008). The MOH recommend that those living in the South Island of New Zealand consider taking vitamin D supplementation through the winter months of May to August, due to the region's high latitude. Southerners may not receive adequate UVB levels, which may lead to a vitamin D deficiency (NZ Ministry of Health, 2016; Johnston, McKenzie & Liley, 2017).

Vitamin D production via UVB rays is normally adequate in the skin to meet the needs of the body, particularly in tropical and subtropical areas. However, even in these climates people may suffer a deficiency if they spend most of their time indoors or are completely covered when outdoors. A deficiency can also occur in people who live in areas of heavy sky pollution or areas with insufficient UVB exposure in winter (Peters, 2014).

There are groups of individuals which are also more at risk of deficiency than others. Dark-skinned people are one such group, as the melanin in the skin absorbs the UV; therefore, it is recommended that time spent in the sun is 5-10 times longer than for those with lighter skin (Truswell & Mann, 2012). The aged are another group whose risk factor for deficiency is increased, as their skin lacks the capacity to synthesise vitamin D (Statistics New Zealand, 2017) due to a decrease in the starting material, 7-dehydrocholesterol. According to Truswell and Mann, those who are overweight or obese are also at risk, as the "excess adipose tissue sequesters vitamin D intake" (p. 249).

People who live in the South Island have a clear risk of becoming vitamin D deficient, particularly if individuals spend little time outdoors. This is due to the high latitude on which the South Island and, in particular, Invercargill, are positioned (Johnston, McKenzie & Liley, 2017). At high latitudes, UVB rays may not be as available for vitamin D production as is the case at mid- to low-range latitudes. Johnston et al. have shown that in Invercargill, the UV available for vitamin D production (UVvitD) is 0.02 ± 0.01 in winter, compared to Auckland's UVvitD, which is 0.08 ± 0.02. A further comparison shows Brisbane's UVvitD as 0.25 ± 0.05 in winter (Johnston, McKenzie & Liley, 2017). Additional calculations carried out by Johnston et al. (2017) showed that people living in Invercargill have a shorter effective period than Auckland residents for vitamin D production. Furthermore, figures from Statistics NZ show that 49.3% of the Invercargill workforce potentially work indoors (Johnston, McKenzie & Liley).

There is a substantial link between vitamin D and wellness. This study is designed to test this finding further by investigating vitamin D supplementation during winter, and by measuring its effectiveness in the form of a wellness questionnaire.

The aim of this research is to examine the possibility that vitamin D supplementation may improve mood during wintertime in Southland, when UVB levels are low and a vitamin D deficiency may be present. Both an intervention group and a control group took part in the study. The investigation was undertaken by providing vitamin D supplementation to a randomised intervention group and measuring mood through mood surveys conducted at the beginning and conclusion of the supplementation period completed by both the control and intervention groups. A positive outcome would be demonstrated if the intervention group showed a marked improvement in their mood and wellness levels at the conclusion of the supplementation period.

METHODS

Participants

The participants recruited for the study were 20 Invercargill office workers (16 female, four male), aged between 28 and 65 years (average age 48 ± 11.44). Participants were provided with information on vitamin D and subsequently signed informed consent forms. Participants were required to be over 18 years of age, not currently taking vitamin D supplementation and not under medical care for a mood disorder.

Testing Procedure

In order to determine that vitamin D supplementation positively affects mood and wellness in winter, the participants (n=20) were randomised between an intervention group (n=10), which received vitamin D supplementation of 1000 IU for 30 days, and a control group (n=10), which did not receive the supplementation. The supplementation period was implemented in the month of August 2016.

A follow-up email was posted a week after, asking for confirmation of participation. Participants then completed two surveys (adapted from Lam, 1998 and RAND, 2017). The first contained six questions designed to ascertain the wellness and mood status of the participants over previous winters, as well as the participants' status before the intervention group undertook vitamin D supplementation. A second, two-question, survey was completed by all participants at the conclusion of the 30-day supplementation period to ascertain their current mood and wellness status. The results of these surveys were analysed to examine the effects of vitamin D supplementation on mood. The questionnaires were adapted to suit the requirements of this study.

Dietary Supplement

A local pharmacy provided the vitamin D supplements, along with capsule containers and labels that provided instructions. The supplementation protocol was 1000 IU of vitamin D3 (cholecalciferol 25mcg) per day in accordance with MOH guidelines, in addition to the labelled instructions on the Good Health Vitamin D supplements, for a period of 30 days (NZ Ministry of Health, 2016).

Statistical Analysis

A statistical analysis was carried out using Microsoft Excel to find mean, standard deviation and percentage figures in order to measure and compare the results from the two questionnaires. Results were deemed significant if $p \leq .05$. Utilising Microsoft Excel, an independent t-test (two-tailed) was used to determine differences within and between groups.

RESULTS

Descriptors and Characteristics of Participants

A summary of the participants' characteristics is shown in Table 1. A further summation of results from the questionnaire found that participants (n=20) felt that their mood was affected by the season, with 75% of participants agreeing with this. Summer was the season that participants (n=20) felt the best (85%); the remainder reported that no particular season made them feel better. Winter was the season in which participants (n=20) felt worst (80%), with the remainder divided between spring (5%) and no particular season (15%).

Demographic	Mean
Average age	48 years old (±11.44)
Female participants	16
Male participants	4
Percentage of participants who work indoors	100%
Percentage of participants who spend leisure time indoors	63%
Hours spent outdoors	7.43 (± 6.32) hours per week
Leisure time spent being active	9.36 (±9.28) hours per week
Does season affect mood?	Yes: 75%
	No: 25%
Season in which participants felt best	Summer: 63%
	Spring/Summer: 26%
	No change seasonally: 11%
Season in which participants felt worst	Winter: 84%
	Spring: 5%
	No change seasonally: 11%
Do you slip, slop, slap and wrap?	Yes: 53%
	Sometimes: 21%
	No: 26%

Table 1. Mean descriptive and characteristic data of participants (n=20)

Mood Rating

There was a significant difference between the intervention group and the control group for perceived improved mood over a 30-day period ($p<.05$). The intervention group results showed an 80% mood improvement over a 30-day period. The control group results showed a 20% mood improvement over a 30-day period (Figure 1).

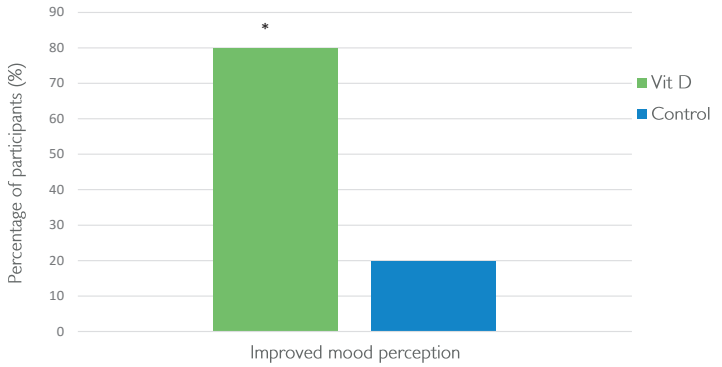

Figure 1. The percentage of participants showing a perceived improved mood for both intervention and control participants (n=20) over a 30-day period. *Significant difference between intervention and control group $p<.05$

Figure 2 shows that 30% of the intervention participants reported a "somewhat low" mood at the beginning of the study; however, at the conclusion of the supplementation period no participants (0%) reported a "somewhat low" mood. A "slightly low" mood was felt by 50% of the intervention participants at the beginning of the study, but by day 30 only 30% of intervention group participants reported a "slightly low" mood. Twenty percent of participants reported feeling no change in mood from usual on day one; this increased to 70% of participants experiencing no change in mood from usual at the conclusion of the supplementation period.

The control participants' results from day one to day 30 remained relatively unchanged. Figure 3 shows that 10% of participants perceived a "somewhat low" mood on day one, and this remained unchanged on day 30. A "slightly low" mood was experienced by 40% of participants on day one, reducing to 30% by day 30. Forty percent of participants perceived no change in their mood from usual on day one; this figure increased to 50% on day 30.

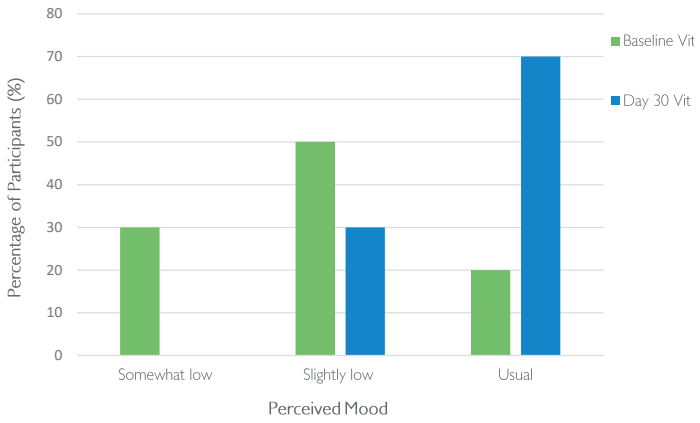

Figure 2. Percentage change of mood perception comparing pre-intervention and post-intervention for intervention participants (n=10)

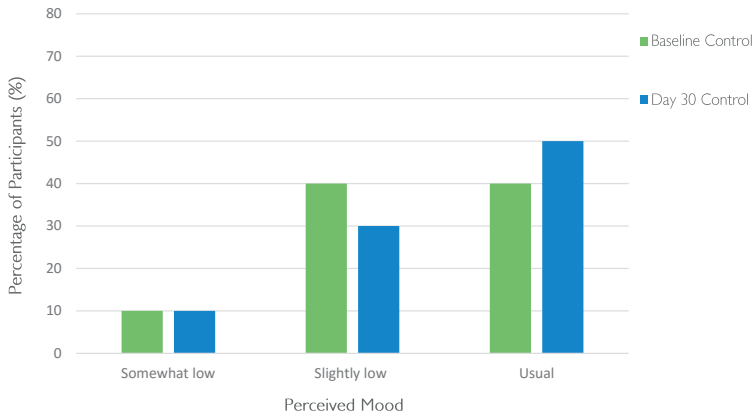

Figure 3. Percentage change of mood perception comparing pre-intervention and post-intervention for control participants (n=10)

	No change (%)	Slight–Marked change (%)
Sleep length	30	70
Social activity	30	70
Mood	25	75
Weight	25	75
Appetite	30	70
Energy levels	20	80

Table 2. Percentage degree of seasonal change for all participants (n=20)

The results also show that weight, sleep length, appetite, social activity and energy levels (Table 2) were all subject to seasonal change, with 70% or more of the participants (n=20) noticing a change in their behaviour.

Winter Mood Characteristics

When participants were asked to think back to previous winters, their (n=20) reports ranged from a "slightly low" mood (50%) to a "very low" mood (6%), with 22% noting no change in their mood over previous winters compared to normal. When considering the winter of 2016 (the study year), 45% of participants reported a "slightly lower" mood than usual, 20% reported a "somewhat lower" mood than usual, and 35% experienced no change in their mood from usual. A comparison of perceived mood over previous winters with the winter of 2016 (Figure 4) shows that participants' (n=20) mood improved in winter 2016; 22% reported a "somewhat low" mood in previous winters, improving by 2% in 2016, while 22% experienced no change in mood in previous winters, improving by 13% in 2016.

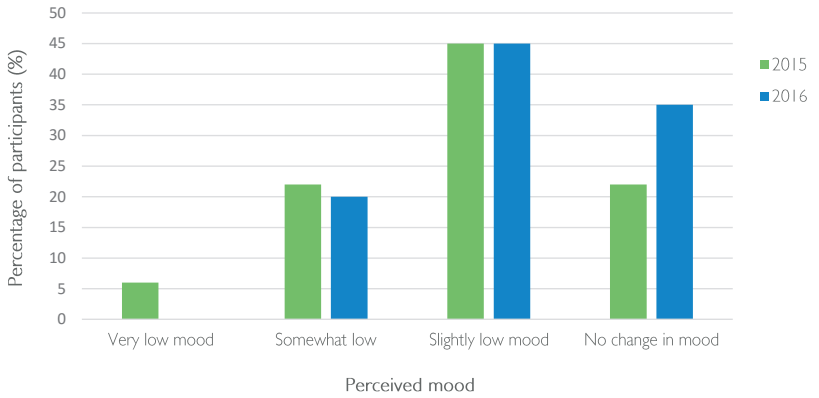

Figure 4. Winter mood characteristics, comparing the winter of 2015 against the winter of 2016 for all participants (n=20)

DISCUSSION

The results of our research indicate that mood is subject to seasonal change, and that vitamin D supplementation did improve mood for the intervention group over the supplementation period. The results show that vitamin D supplementation is effective in improving mood over winter, with 80% of the intervention group noting an improvement in perceived mood between day one and day 30 of vitamin D supplementation. These findings are consistent with those of Lansdowne and Provost (1998), who found that positive affect increased and negative affect decreased after five days of 800 IU per day of vitamin D supplementation; and with those of Berk et al. (2007) and Murphy and Wagner (2008), who also found that vitamin D supplementation improved mood scores. These results stand in contrast to those for the control group in our study, which showed only a slight increase in mood over the same period.

Most participants (75%) agreed that their mood is affected by the season. Lansdowne and Provost (1998) suggest that mood affected by the season exists on a continuum from no change in mood to a very low mood. With the exception of 20% of the intervention group, who experienced no change in their mood from season to season, the remaining 80% experienced an increase in mood after 30 days of vitamin D supplementation. By contrast, the control group remained relatively unchanged, with only 20% experiencing an increase in mood during the same period.

All the participants in our study worked indoors, which is a contributing factor to vitamin D deficiency according to the MOH (NZ Ministry of Health, 2016). Although the participants stated that they engaged in an average of 9.36 (±9.28) hours of leisure activity per week, only 35% recorded that their leisure time was spent outdoors, with the average hours per week spent outside being 7.43 (± 6.32). The lack of time outdoors exposed to UVB light is a contributing factor to vitamin D deficiency. For Invercargill residents, it is recommended that to obtain sufficient vitamin D levels, three hours in the outdoors per day would be required during winter (Harding, 2010 & Page, 2017).

Globally, fear of skin damage or cancer has led to more individuals covering up in summer, with 52% of participants in this study doing this; a further 21% reported that they sometimes covered up in summer (Murphy & Wagner, 2008). This factor, combined with a relatively small amount of time spent outdoors, increases the risk factor for vitamin D deficiency. People who spend adequate time exposed to UVB light will maintain adequate stores of vitamin D – which may explain why some individuals experience nil change in their mood from season to season (Murphy & Wagner, 2008).

In our study, weight, sleep duration, appetite and energy levels were all subject to seasonal change, with 70% of participants noting a "slight" to "marked" change in their behaviour. A decrease in socialisation and a lack of energy was also experienced by 80% of participants. While these changes occur in normal populations during winter, they also match the symptoms of vitamin D deficiency (Lansdown & Provost, 1998).

Of special interest is the comparison we made between previous winters and the winter of 2016 (Figure 4). The results show that participants experienced a lower mood in previous winters than in the winter of 2016. A previous study carried out on SAD (Cabellero, 2009) reported that in addition to sunlight hours positively affecting mood, rainfall and low temperatures also negatively affect mood, especially rainfall. The National Institute of Water and Atmospheric Research (New Zealand) (NIWA, 2016) produced a climate report for August 2016, the month of the vitamin D supplementation period in our study. The report showed that while temperatures were below average (-1.2°C to -0.51°C), sunshine hours were above average across the country (110-125% of normal) and rainfall was well below average in the South Island (<50%), with January to August 2016 being the warmest recorded period over the seven-station temperature record. These weather results may have had an impact on the findings of our study, in that participants had not experienced the usual run of winter weather that may contribute to lower than usual mood levels.

The limitations of this study lie mainly with the small sample size; a larger sample size would provide a more accurate representation of the population. In addition, there may be compliance issues with taking the supplement for a period of 30 days, which will affect the accuracy of the results. Another limitation was that there were no double-blind trials, which would have strengthened the study.

While our research has shown that vitamin D supplementation can positively affect mood, in order to consolidate these findings, a double-blind protocol with a larger sample size and serum testing to compare vitamin D levels with the level of mood perceived is recommended.

CONCLUSION

The results showed a significant improvement in participants' mood after the 30-day vitamin D supplementation period. Our findings support the evidence of the literature that vitamin D deficiency can adversely affect wellness by lowering mood and energy levels, increasing appetite, causing a lack of sleep and increasing susceptibility to infection (Peters, 2014). As a result, it is imperative that vitamin D levels be maintained at recommended levels in order to reduce the negative risk to health and wellness.

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