Relationship between serum 25-hydroxyvitamin D levels and fall risk as measured by dynamic stability and mobility-related outcomes in older adults

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Background

Sufficient vitamin D is critical for infant and childhood bone growth, but is additionally implicated in chronic disease risk in adults. In particular, low circulating levels of the vitamin D catabolite, 25-hydroxyvitamin D [25(OH)D], have been reported to be related to decreased muscle function and increased risk of falls in older adults[1-3]. However, the remedial benefits of vitamin D supplementation as a standalone treatment to increase muscle strength and reduce fall risk are tenuous and sometimes contradictory across published clinical studies[4,5]. We set out to investigate the relationship between serum 25(OH)D and mobility-related outcomes and fall risk among community-dwelling older adults.

Severe muscle loss in older adults – sarcopenia – is often ancillary to frailty. Similar to frailty, sarcopenia is highly correlative of increased risk of falls, impaired ability to perform ADLs, and loss of independence[6-8]. Declining muscle mass and strength are expected components of ageing; however, the rate of decline differs across the elderly population, suggesting that modifiable behavioral factors such as diet and lifestyle, may influence muscle function and therefore may be amenable to intervention [9,10]. The role of vitamin D in maintaining skeletal health is well known, however, its role in relation to physical performance is still limited, and it is unknown whether vitamin D status can predict decline in physical performance. Moreover, pertinent to our investigation, only a few studies have objectively measured dynamic stability of walking in relation to vitamin D status (as measured by serum 25(OH)D levels). In small exploratory studies, dynamic stability segregates with fall-prone status in older subjects[11,12]. Dynamic stability may thus explain the link between vitamin D and fall risk. To our knowledge, this is the first study to test dynamic stability and vitamin D status (serum 25(OH)D levels.

Objective

The focus of this study was on assessing the relationship between serum 25(OH)D level and fall risk, as measured by dynamic stability of walking utilizing gait parameters derived from inertial measurement units (IMUs- composed of tri-axial accelerometer and gyroscopes).

Method

A total of 34 participants (13 Male, 21 Female) were screened from community dwelling elderly individuals from a local retirement community. Prior to data collection a written consent was obtained. The participants were divided into three groups: Highly sufficient (HS), Low sufficient (LS) and Insufficient (INS). In this analysis, we compared Highly Sufficient (above 40 ng/ml) group to the Insufficient group (below 30 ng/ml) in this analysis to clearly differentiate the groups (i.e., at least 10ng/ml level separation). (Table 1).

Table 1. Anthropometric table of the participating population with serum level the vitamin D catabolite, 25-hydroxyvitamin D [25(OH)D]

Vitamin D levels	Analysis Columns	N	Mean	Std. Dev
Highly Sufficient (Above 40ng/ml)	Age (yrs.)	9	82.77	3.59
	Height (cm)		167.56	10.01
	Weight (kg)		75.86	18.19
	Vitamin D3 level (ng/ml)		45.84	4.87
Insufficient (Below 30 ng/ml)	Age (yrs.)	9	74.77	7.55
	Height (cm)		163.22	8.57
	Weight (kg)		89.72	22.13
	Vitamin D3 level (ng/ml)		22.88	6.70

Fig 1. Participant performing walking task and placement of IMU

Quickly local dynamic stability was quantified by the maximum Lyapunov Exponent (maxLE) from a nonlinear dynamics approach. Briefly, each experimental time series measurement (e.g. acceleration measures at the whole body center of mass while walking for 6 minute to assess 40 gait cycles) can be reconstructed into a state space with sufficient dimensions to describe the target dynamic system unambiguously (Figure 2 and 3).

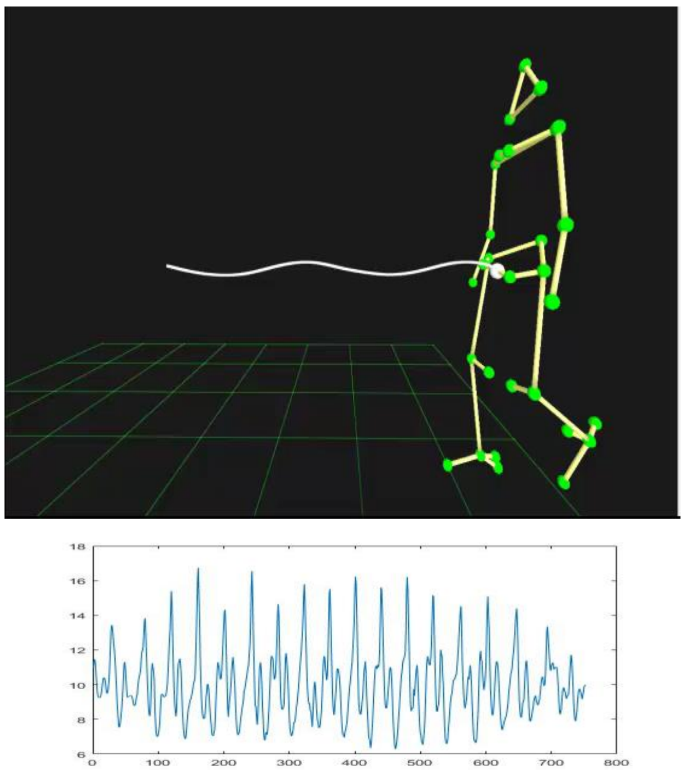

Fig 2. Tracing of the whole body COM and resultant trunk acceleration data

Results

One-way ANOVA using the independent variable vitamin D level (Highly Sufficient and Insufficient) and the dependent measure dynamic stability indicates a significant differences in dynamic stability measures associated with VitD levels (F-ratio =4.60, p=0.049: Highly Sufficient (mean =1.55, SD=0.14) and Insufficient (mean=1.70, SD=0.13) (Figure 3) (lower dynamic stability index indicates **less trajectory divergence** and **stable motion pattern**).

Bivariate relationship between vitamin D level and dynamic stability measure indicates R^2 =0.28, p=0.03 (Figure 4). The relationship is expressed as:

Dynamic Stability = 1.8357457 - 0.0059743*Vitamin D Level (ng/ml)

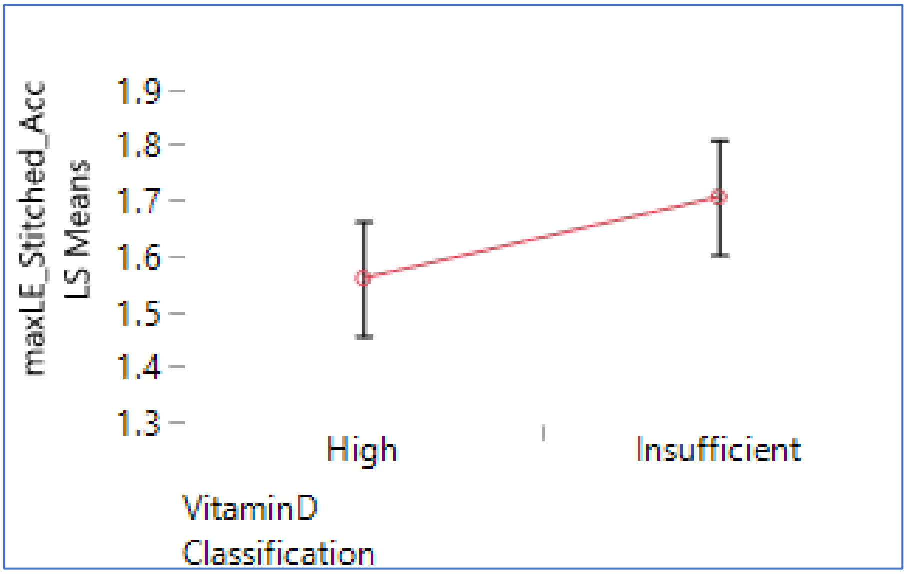

Figure 3. Effects of serum level (the vitamin D catabolite, 25-hydroxyvitamin D [25(OH)D]) and dynamic stability (as measured by maxLE_Stitiched_Acc).

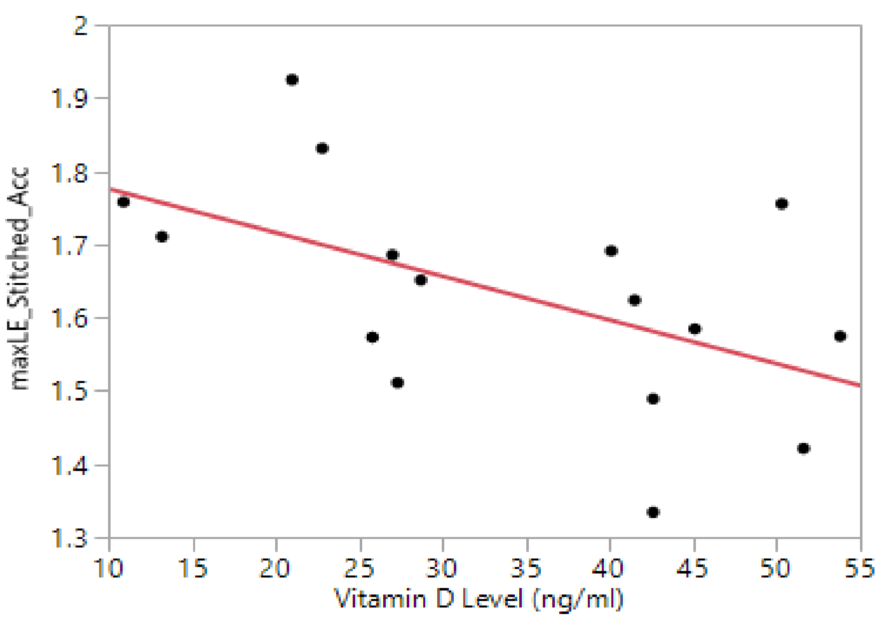

Figure 4. Bivariate relationship between serum level (the vitamin D catabolite, 25-hydroxyvitamin D [25(OH)D]) and dynamic stability.

Conclusion

The current study found a significant difference in dynamic stability associated with serum vitamin D levels between highly sufficient group and insufficient group. Additionally, 28% of variability was attributed to dynamic stability between groups. These results suggest that fall risk is higher in the insufficient group and may benefit from vitamin D supplementation.

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