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Research Article

Are you Lactose Intolerance and from an Ethnic Minority? A Study on the Effect of Lactose Intolerance on Loss of Bone Mineral Density-Case Study Lewisham Greenwich Hospital

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Abstract

Lactose Intolerance (LI) is a natural process where production of lactase, an intestinal disaccharide, decreases during the aging due to lack of consumption. There are several sub-types of lactose tolerance: Lactose Tolerant (LT), Lactose Intolerant (LI) and Lactose Mal-absorber (LM). Osteoporosis (OP) is a degenerative endocrinal bone disorder affecting over 200 million people worldwide whereas LI affects up to 70% of the world's population and approximately 15% of the UK population. OP develops predominantly with age and affects mainly women due to hormonal imbalance post-menopause which when coupled with lack of dairy intake, a key source of lactase and calcium required for bone ossification, leads to the increased bone loss. Understanding the association between LI and OP can lead to better prognosis, prevention technique and treatment.

Aim

Firstly, identifying patients suffering from lactose intolerance that belong to different ethnicities and determining the effect of lactose intolerance on Bone Mineral Density (BMD) and thus osteoporosis. Secondly, determining the prevalence of lactose intolerance in different ethnicities using a case study based in Lewisham Greenwich Hospital, London, UK.

Introduction

Lactose is a disaccharide (two-sugar molecule) naturally found in dairy products and is a major form of energy in infants. However, it has other functions including promotion of beneficial bacterial growth and aid of mineral absorption. Lactose intolerance is defined as an individual's 'inability to digest lactose' [1] which is fermented by bacteria present in the digestive system. A general fall in lactase concentration is expected in adults due to milk not being the primary source of energy, however, a significant decrease in lactose can result in complications and development of other disorders such as low bone mineral density followed closely by osteoporosis. Several risk factors for the development of lactose intolerance exist, these are mainly due to lifestyle factor as only genetically inherited lactose intolerance cannot be prevented. It is important to ensure this condition is prevented to the greatest extent as there are no current treatments available apart from taking supplementary lactase.

Milk is a high lactose containing product and is also one of the most common source of calcium, and many vitamins including vitamins A, C, D and riboflavin which are essential for bone strength. A decrease in calcium, a key constituent of the collagen matrix of bone and one of the key minerals responsible for maintaining cellular membrane potential, can lead to compromised bone strength due to lower bone mineral density, i.e. osteopenia or osteoporosis.

Methodology

Data obtained throughout the course of this work was courtesy of Lewisham Greenwich Hospital, London, UK, which was obtained during clinical placement. A total of 353 patients were involved of different gender, age range and ethnicities with an approximate ratio of men to women as 1:3. The ratio of lactose intolerant to lactose tolerant was also 1:3 due to some ethnicities being more prone to developing the condition. Care was taken to include similar number of subjects from each ethnicity leading to the ratio observed.

The patients were categorized into age groups, ethnicity and lactose tolerance or intolerance to compare the bone mineral density. (Table 1) shows the number of individuals that are lactose intolerant and tolerant from each ethnicity. It can be observed that the most lactose intolerant ethnicity is Chinese followed by Pakistani and Black whereas the most tolerant is the White.

In the White, Indian, Pakistani and Chinese population, the lactose intolerant females and males had a lower body mass index than their tolerant counterparts. This was not consistent in the Black individuals who exhibited a higher BMI in the intolerant individuals than the tolerant ones. However, this could be associated with the general age of the individuals. The male height was lower in the tolerant group than the intolerant for the White, Black and Pakistani ethnicities whereas this was higher in the Chinese and Indians. However, the females belonging to the Black, Chinese and Indian ethnicities were older than their tolerant counterparts.

Minitab and Microsoft Excel were used to perform statistical analysis. A comparison of the BMD was established across the age-groups for all ethnicities and lactose intolerance/tolerance at the spine and the total hip. A one way Analysis of the Means chart (ANOM) was created to determine the effects of lactose on the BMD at the spine and the femur by observing the difference in population means. Two-sample t-tests was performed to determine whether there is a significant difference between the mean BMD of the lactose tolerant and intolerant individuals belonging to similar ethnicities and then inter-ethnic significance of difference due to lactose intolerance was analyzed.

Results

Using statistical analysis on data obtained from Lewisham Greenwich Hospital, London, UK, of 353 patients belonging to different ethnicities (Black (BI), White (WI), Pakistani (PI), Indian (II) and Chinese (CI) individuals), age range (20-80+ years old) and LI status the significance of the inter-ethnic and intra-ethnic difference was established for LI. 95 males (72 LI, 23 LT) and 258 females (174 LI, 84 LT) participated in the study.

The highest lactose intolerance was observed in the CI and the least in the WI. A lower BMD (g/cm^2) was observed between LI when compared to LT groups with WI (0.70 *vs*. 0.89), BI (0.88 *vs*. 0.92), CI (0.76 *vs*. 0.79), PI (0.81 *vs*. 0.90) and II (0.75 *vs*. 0.83).

At the hip, comparing LT WI with LT and LI individuals from other ethnicities, it was observed that a significant difference (SD) existed ($p<0.05$) between CI ($p=0.00$), II ($p=0.00$) and PI ($p=0.009$) that are LI when compared to LT WI. However, no SD existed ($p>0.05$) between LT WI when compared to BI that are LI ($p=0.49$) and CI ($p=0.35$), PI ($p=0.85$), BI ($p=0.62$), II ($p=0.12$) that are LT.

Table 1: Lactose tolerance by ethnicity.

	Intolerant (Yes)		Tolerant (No)	
	F	M	F	M
White	5	1	51	13
Black	43	12	11	5
Pakistani	43	16	10	1
Chinese	44	24	3	1
Indian	39	19	9	3

Similar results were observed at the spine where no SD was observed when comparing LT WI and LI ($p=0.24$) and LT (0.17) BI. Likewise, LT CI ($p=0.16$) and PI ($p=0.93$) also displayed no SD. Alternatively, SDs were observed between LT WI and LI CI ($p=0.00$), II ($p=0.00$) and PI ($p=0.01$). However, SD also existed between LT WI and LT II ($p=0.02$).

Discussions

Two sample t-tests conducted at the hip and the spine confirmed a difference between the lactose tolerant and intolerant groups and as the difference estimated was positive, a higher BMD was observed in the lactose tolerant group. This is due to an increased likelihood of consumption of dairy products when compared to lactose intolerant groups. Calcium content also varies in different foods such as milk, yogurt, vegetables, cheese, nuts, etc. However, milk contains the highest amount of calcium whereas cheese and nuts contain considerably less. Also, lactose content of both foods are highly different where a higher lactose content is observed in the milk and lower in the cheese and nuts. A lactose intolerant individual would be more likely to opt for foods containing the least amount of dairy to obtain calcium or take supplementary calcium to prevent low calcium levels and bone mineral loss through sweat and waste. Another effective use for calcium is to reduce thyroid levels hence a decrease in calcium levels leads to hyperthyroidism which is a risk factor for secondary osteoporosis [2]. However, supplementary calcium also has side-effects including constipation, nausea, headache, dizziness, vertigo, unusual tiredness [3].

Individuals belonging to the Western community originate from different countries due to the ethnic variety present in the country. Hence, the Western diet is not a typical British/White diet as it is a combination of several ethnic diets and is consumed mainly in developed countries such as America or UK. As a result it is important to study the effect of lactose intolerance on bone mineral density and its effect due to ethnic origin.

Effect of ethnicity

Considering the comparison of the different ethnicities with lactose tolerance and intolerance to White as a reference, it is observed that even though bone mineral density loss in life is inevitable, the presence of lactose intolerance plays an important role in the difference in bone mineral densities observed in different ethnicities.

From the sample, approximately 77% of the Black population, 94% of the Chinese population, 83% of the Indian, 84% of the Pakistani and a mere 9% of the White population was lactose intolerant. The remaining percentage from each ethnicity was lactose tolerant. A lower mean BMD was observed in the lactose intolerant group when compared to the lactose tolerant group for all ethnicities at both sites (Table 2). The highest difference was observed at the hip in the White population. The second highest difference was present in the Pakistani and Indian ethnicity. The highest percentage difference was similar at the spine in the White population. However, the Indian displayed the second and Chinese the third highest percentage difference.

When considering different age groups, a higher bone mineral density is observed in the tolerant individuals than the intolerant individuals as depicted in Table 2. For the 80+ year's age range at the hip, a higher bone mineral density is detected in the intolerant group than the tolerant ones possibly due to obtaining calcium

from alternative sources. Also, a lower number of lactose tolerant individuals were found in the sample which could explain the mean lower bone mineral density observed that is not representative of the population as a whole.

At the spine, similar trends are observed where a lower bone mineral density is present in the lactose intolerant individuals. However, when the 80+ year's age range is extracted, a higher bone mineral density is observed in the Black lactose intolerant individuals than the lactose tolerant individuals. A high prevalence of lactose tolerance exists in this ethnicity as individuals are not commonly fond of consuming milk, as also observed by Garza et al. [4], hence lack of calcium resulting in low bone mineral density. Some ethnicities exhibit higher bone mineral densities than others [5-11] and this difference also exist when comparing the BMDs of lactose tolerant individuals with intolerant ones. A comparison of the White lactose tolerant individuals with lactose tolerant individuals from other ethnicities displayed no significant difference in bone mineral densities; however, significant differences existed when a similar comparison was drawn between White lactose tolerant individuals and lactose intolerant individuals from other ethnicities. Through t-tests, it was established that a significant difference existed between lactose tolerant individuals from the White ethnicity and lactose intolerant Chinese, Indian and Pakistani individuals. However, the Black population did not exhibit any significant difference regardless of the prevalence of lactose intolerance in the population.

Dairy products form a major part of the White population diet hence the prevalence of lactose intolerance in this ethnicity is low. However, if an individual does suffer from lactose intolerance it has a higher impact on the bone mineral density as calcium deficiency and insufficiency is observed. This leads to lower serum calcium levels and when this is coupled with the highly acidic Western diet (high in sodium, sugars, fats, proteins, etc), calcium is depleted from the reservoirs to neutralise the acidity through the action of parathyroid hormone leading to lower bone mineral density and higher rate of osteoclasts to ensure enough calcium is available. Additionally, lack of exposure to sunshine can also result in lower amounts of Vitamin-D production leading to a further BMD loss as mineralization is insufficient due to lack of absorption of calcium. As shown in Table 3, UK has the highest consumption of milk up to 112.7kg per capita in 2009 [12]. A study conducted by Bannan et al. stated that 80-99 % of the Northern and Middle European population is lactose tolerant [13]. However, if the required calcium levels are obtained in the lactose intolerant individuals, it is possible that a higher BMD could be achieved as the balance between magnesium and calcium would be better maintained leading to optimum functionality of the osteoblasts and therefore stronger bone.

Contradicting to the White ethnicity, milk-a key source of calcium (300mg per cup [12]) is consumed in low amounts in southern Africa as shown in (Table 3). This is coherent with lactose intolerance observed in this population [14]. Milk consumption is low in Black individuals residing in the UK when compared to the White ethnicity as consumption of retinol, Vitamin-C, Vitamin-D and riboflavin (commonly found in milk) is lower. Lactose intolerance causes mal-absorption of calcium and joint with lack of vitamin-D, can cause bone fracture which is more fatal in Black women than in any other ethnicity. However, regardless of lactose intolerance the Black population in the sample showed no significant difference in bone mineral density when compared to that of a healthy White young male. Possible reasons include higher oestrogen levels than other ethnicities, sufficient calcium intake from alternative sources in these individuals and when this is coupled with a high magnesium intake, higher bone mineral density can be produced. Additionally, low amounts of sodium are consumed in the traditional diet which creates a more alkaline internal environment resulting in more calcium being stored into the bones and teeth thus increasing bone mineral density.

Another ethnicity that rarely consumes lactose is the Pakistani as most of the time milk is used to create desserts which is consumed in plentiful. The consumption of milk in Pakistan per capita was 100.8kg in 2009 [12] which is the second largest consumption for the ethnicities in question as shown in Table 3. Regardless of milk consumption, over 60% of the population suffers from lactose intolerance [13]. This is analogous to the 84% of the sample being lactose intolerant. Milk consumption is relatively low in Pakistani individuals residing in the UK when compared to the White ethnicity as consumption of retinol, Vitamin-C, Vitamin-D and riboflavin (commonly found in milk) is lower than the White and the Black population. Majority of the Pakistani sample either suffered from low bone mineral density (osteopenia) or osteoporosis and a plausible reason for this is the association of high lactose intolerance prevalence with the bone mineral density. Furthermore, the ratio of males to females in the Pakistani sample was approximately 1:3 and as most Muslim females use a veil to cover themselves, low Vitamin-D is also observed in this ethnicity [14,15]. This further decreases lactose tolerance in the individuals as Vitamin-D is associated with calcium absorption. Over time, lack of absorption leads to low serum calcium and when this is coupled with a high sodium, sugar and protein diet, low bone mineral density is observed.

Table 2: Lactose and its effect on BMD in different ethnicities.

		LT		LI		% Diff
	Ethnicity	**N**	**Mean**	**N**	**Mean**	
Total Hip BMD	Black	16	0.922	55	0.879	4.7
	Chinese	4	0.788	68	0.758	3.8
	Indian	12	0.831	58	0.752	9.6
	Pakistani	11	0.899	59	0.811	9.7
	White	64	0.891	6	0.701	21.3
Spine BMD	Black	16	0.917	55	0.897	2.1
	Chinese	4	0.76	68	0.695	8.5
	Indian	12	0.8	58	0.726	9.3
	Pakistani	11	0.863	59	0.801	7.2
	White	64	0.867	6	0.699	19.4

Table 3: Milk consumption in selected countries [12].

Countries	Milk Consumption Per Capita (kg)
China	27.5
India	43.6
Pakistan	100.8
South Africa	41.5
United Kingdom	112.7

Due to religious beliefs, little amount of calcium and 'complete' protein is found in the Indian diet along with high amounts of vegetables and lentils. This is in conjunction with the low bone mineral density observed in the population. As the prevalence of lactose intolerance is higher in South India [16], it is possible that the sample included more South Indians. Pure orthodox Indians rely on vegetables and lentils to obtain all of the nutrients required. However, most of the nutrients are not sufficiently obtained from vegetables alone, for example; amount of calcium in leafy vegetables is lower than that of dairy products. Lack of calcium intake therefore results in lower serum calcium and insufficient mineralization of the bone matrix. Moreover, if a high sugar or sodium diet is consumed, as it is by the Western Indian ethnicity, a higher constant acidic internal environment would be established which results in lack of absorption and excessive depletion of calcium through the increased activity of parathyroid hormone and decreased activity of calcitonin. Therefore, compared to the White sample lactose tolerant and intolerant individuals exhibited a lower bone mineral density. The consumption of milk in India was 43.6 kg per capita in 2009 [12] which are significantly less than its Pakistani counterpart. This is congruent with the lactose intolerance prevalence in the ethnic origin as 83% of the sample was found to be unable to digest lactose.

Similar to the Indian population, Chinese also exhibit a high amount of bone mineral density loss regardless of lactose intolerance when compared to the normal White lactose tolerant individuals. However, when mean BMD of lactose tolerant individuals was compared to the lactose intolerant ones, no significant difference was observed. The taste of milk is generally not preferred by the Chinese population hence, the consumption of milk per capita was 27.5kg in 2009 [12] which is the lowest consumption for the ethnicities in question as shown in (Table 3). This is consistent with the 90% lactose intolerant population [13] and 94% lactose intolerance in the sample (6% lactose tolerance). Therefore, Chinese also rely on alternative sources of calcium and are unable to obtain sufficient amounts to maintain a normal bone mineral density. Even though Chinese consume low levels of sodium when compared to other ethnicities, other lifestyle factor such as high alcohol consumption and smoking habits create the highly acidic internal environment which increases parathyroid activity leading to decrease in bone mineral density. Furthermore, integration of Chinese traditional diet with a Western diet would increase the level of sodium and sugar consumed by the ethnicity.

Furthermore, the introduction of fast food chains has introduced a high amount of cholesterol, fatty acids, sugars and preservatives into the diet of all Western individuals (White, Black, Indian, Pakistani and Chinese).

As with any clinical study, there were several limitations associated with the current data and analysis. Subjects involved in the study were lactose intolerant, but there are four major types of lactose intolerance which can affect the development of osteoporosis in individuals such as a lactose mal-absorber or primary lactose deficient individual cannot consume dairy products that contain high amounts of calcium but consume little amounts of lactose in some dairy products such as cheese. However, secondary lactose intolerant individuals may have a higher intolerance. The level of lactose intolerance was not specified for any of the individuals which can have a significant effect on the bone mineral density of the individual. Furthermore, no test was performed to confirm lactose intolerance and this condition was confirmed only by the patient. Ethnicity was recorded in a discrete manner which means that inter-breeding was not taken into account.

Conclusions

Results indicate that regardless of the effect of ethnicity, bone mineral density loss is affected by the absence of lactase (enzyme found in the small intestine of mammals that catalyses the breakdown of lactose (milk sugar) into the simple glucose and galactose) leading to a lower bone mineral density in LI individuals. From the sample approximately 77% of the BI, 94% of the CI, 83% of the II, 84% of the PI and a mere 9% of the WI were lactose intolerant. This could be a plausible reason for the lower BMD observed in certain ethnicities. However, the effect of severity of LI should also be considered in order to reach a more definitive conclusion.

References

1. Gale Encyclopedia of Medicine. Lactose Intolerance. 2008.
2. Causes of Osteoporosis.
3. British National Formulary. BNF -Medicines complete.
4. Garza C, Scrimshaw NS. Relationship of lactose intolerance to milk intolerance in young children. The American Journal of Clinical Nutrition. 1976; 29: 192-196.
5. Linda DW, Matthew CJ, Tristan DS, Bryan LH. Racial/ethnic differences in bone mineral density of young adults. International Journal of Exercise Science. 2010; 3: 197-205.
6. Araujo AB, Travison TG, Harris SS, Holick MF, Turner AK, McKinlay JB. Race/ethnic differences in bone mineral density in men. Osteoporosis international. 2007; 18: 943-953.
7. Nam HS, Shin MH, Zmuda JM, Leung PC, Barrett-Connor E, Orwoll ES, et al. Race/ethnic differences in bone mineral density in older men. Osteoporosis international. 2010; 21: 2115-2123.
8. Looker AC, Orwoll ES, Johnston JR, Lindsay RL, Heinz WW, William LD, et al. Prevalence of low femoral bone density in older US adults from NHANES III. Journal of Bone and Mineral Research. 1997; 12: 1761-1768.
9. Elizabeth BC, Ethel SS, Lois EW, Paul DM, Thomas AA, Berger ML, et al. Osteoporosis and fracture risk in women of different ethnic groups. Journal of bone and mineral research. 2005; 20: 185-194.
10. El-Hajj GF, Baddoura R, Awada H, Salam N, Salamoun M, Rizk P. Low peak bone mineral density in healthy Lebanese subjects. Bone. 2002; 31: 520-528.
11. Hammoudeh M, Al-Khayarin M, Zirie M, Bener A. Bone density measured by dual energy X-ray absorptiometry in Qatari women. Maturitas. 2005; 52: 319-327.
12. Databank. Helgi Library. 2009.
13. Patricia MB, Michael DL. Calcium, dairy products, and osteoporosis: Implications of lactose intolerance. Primary Care Update for OB/GYNS. 1996; 3: 146-151.
14. Md Z. Islam, Mohammed A, Christel LA. Hypovitaminosis D is common in both veiled and nonveiled Bangladeshi women. Asia Pacific journal of clinical nutrition. 2006; 15: 81-87.
15. Lowe NM, Basma E, Bano Q, Sonia AB, Soma R. Mitra, Zaman M. Dietary calcium intake, vitamin D status, and bone health in postmenopausal women in rural Pakistan. Journal of health, population, and nutrition. 2011; 29: 465-470.
16. Tandon RK, Joshi YK, Singh DS, Narendranathan M, Balakrishnan V, Lal K. Lactose intolerance in North and South Indians. The American Journal of Clinical Nutrition. 1981; 34: 943-946.