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Risk factors for osteoporosis in South Asian and Caucasian postmenopausal women

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Abstract

Objective: There is evidence to show that the risk of osteoporosis is greater for South Asian females compared to Caucasian females. This is due to differences in bone mineral density and other risk factors which contribute to this condition such as calcium and vitamin D intake and exercise levels. The present study set out to examine such differences between these two communities. Postmenopausal females were studied as the risk of osteoporosis is greater after the menopause.

Design: Bone mineral density was assessed using the Achilles Insight heel scanner, dietary intake was assessed using a 24 hour recall and lifestyle factors were assessed using a questionnaire.

Setting: North West England.

Subjects: Total participants - 282 Caucasian and 41 South Asian women. Postmenopausal participants – 144 Caucasian and 7 South Asian women.

Results: No significant differences were found in bone mineral density between Caucasian and South Asian females, however differences in other risk factors for osteoporosis such as calcium and vitamin D intake were found between the two communities. There were also significant differences in bone mineral density between pre and postmenopausal participants ($P<0.001$).

Conclusions: Although no differences in bone mineral density were found between the two communities, there were significant differences between the pre and postmenopausal participants.

This shows how important it is to raise awareness of this public health issue and target other factors associated with osteoporosis in already high risk individuals.

Key Words
Osteoporosis
Caucasian
South Asian

Osteoporosis is a disease characterised by low bone mass and structural deterioration of bone tissue, which causes bone fragility and an increased susceptibility to fractures of the hip, spine and wrist (World Health Organisation [WHO], 2011). It is a major public health concern as this condition is responsible for around 1700 fractures a day and 650,000 a year in the European Union alone (WHO, 2006) and 8.9 million a year worldwide (WHO, 2004). The risk of osteoporosis is greater in women than in men, largely due to the menopause, and also greater within South Asian (SA) than Caucasian ethnicities. This is due to a number of factors which contribute to a lower bone mineral density (BMD). Calcium is the main mineral component of bone which is kept in balance with plasma calcium, mainly by vitamin D. The recommendation is 700mg / day (Department of Health [DoH], 1991). Reported calcium intakes within the SA population are low, some studies suggest below 400mg / day (Jackson & Savaiano, 2001). Lowe, Mitra, Foster, Bhojani and McCann (2010) also reported mean dietary calcium intake of their Indian participants was low at 438.6mg / day with 74% of their subjects consuming less than 500mg / day (Lowe, Mitra, Foster, Bhojani, & McCann, 2010). Vitamin D levels within this population are also extremely low as Tahrani, Ball, Shepherd, Rahim, Jones and Bates (2010) found that 81% of their SA participants had inadequate vitamin D concentrations and 14% were deficient (Tahrani, Ball, Shepherd, Rahim, Jones & Bates, 2010). Mitra, McCann, Bhojani, Foster and Lowe (2008) also reported serum vitamin D was significantly lower (P=0.001) in SA women than Caucasian women in their study (Mitra, McCann, Bhojani, Foster, & Lowe, 2008). The majority of vitamin D is synthesised in the skin upon exposure to sunlight. Therefore low levels within this population may be due to increased skin pigmentation and traditional concealment of the body with clothes (Islam et al., 2010). Also, inhabitants of countries above 37°N do not synthesise vitamin D during winter and the UK is above 51°N (Lee, Tan, David, Nurmi-Lawton, Lee, & Lanham-New, 2008). Therefore SA populations within the United Kingdom (UK) are at an even higher risk of vitamin D deficiency.

Regular weight bearing or resistance exercises are also essential for bone health, however levels of physical activity are also lower among SA than the general population in the UK (Fischbacher, Hunt, & Alexander, 2003). As well as increasing the risk of osteoporosis, this may also increase the body mass index (BMI) of SAs. Bush, Williams, Lean and Anderson (2001) found this and reported that SAs are often overweight (Bush, Williams, Lean, & Anderson, 2001). It is also known that obese people store vitamin D in a bio unavailable form in adipose tissue, therefore often have insufficiency (Snijder et al., 2005). This may also contribute to low vitamin D levels within this population.

Despite this evidence, studies comparing BMD between SA and Caucasian women have found conflicting results, some finding significant differences (Hamson, Goh, Sheldon, & Samanta, 2003), (Ward et al., 2007) and others finding no significant differences (Roy et al., 2005). More research

needs to be done in this area to determine whether there is a difference and therefore what measures need to be put in place to improve the bone health of SAs. This public health issue is becoming of an increasing importance due to the increasing number of ethnic groups in the UK (Lupton & Power, 2004).

The present study aims to assess whether there are any differences in bone health between SA and Caucasian women, living in North West England and the subsequent risk of bone related disease. Differences in calcium and vitamin D intake will be measured, as well as other lifestyle factors, to determine whether this has an effect on bone health between the two communities.

Methods

Participants

This observational study recruited Caucasian and SA females, aged over 20 and living in North West England. The sample size was calculated using G Power 3.1. The aim was to enrol 200 participants, 100 from each community, to give 80% power with an effect size of 0.4. Community centres were used to help find SA women, as well as a purposive sampling technique known as 'snowballing'. This method is often used to recruit hidden populations, i.e. groups that are not easily accessible to researchers. An individual who has the desired characteristics for the study, known as the 'source' or 'seed' is identified and uses their social network to recruit similar participants. After the source helps to recruit respondents, the respondents then recruit others themselves, starting a process similar to a snowball rolling down a hill (Sadler, Lee, Lim, & Fullerton, 2010). Suitable participants were identified with the help of the Pakistan Association Liverpool and the Cheshire Asian & Minority Communities Council (CAMCC). Informed consent was gained from all participants and the project received ethical approval from the University of Chester Research Ethics Committee.

Measurements

BMD was measured using the Achilles Insight which uses ultrasound to evaluate bone status in the heel. This machine produces a stiffness index which measures the risk of osteoporotic fracture, and a T and Z score to compare the bone health of the individual to a control. The T-score reflects the number of standard deviations (SD) above or below the mean BMD values for a young healthy adult and the Z-score, the number of SD above or below the mean BMD values for an aged matched population (International Osteoporosis Foundation, 2010). Osteoporosis is diagnosed in relation to T scores. A T score of -1 or above indicates normal bone mass, a T score of between -1 and -2.5 indicates low bone mass, i.e. osteopenia and a T score of below -2.5 indicates osteoporosis (WHO, 1994).

Dietary intake was assessed using a 24 hour recall. A computer software package called Compeat was then used to calculate the nutrient content, specifically looking at calcium and vitamin D. Participants were asked to state their height and scales were provided to obtain their weight. Body mass index (BMI) was then calculated using the equation BMI = weight (kg) / height^2 (m). A questionnaire was also completed by each subject to obtain information on general lifestyle, such as menopausal status, exercise levels and time spent outside of the UK.

Analysis

Statistical tests were performed using a program called SPSS. Normal distribution was first tested. Depending on the outcome of this, either independent t tests or Mann Whitney U tests were performed to determine any difference between all participants of the two communities in:

- BMD, i.e. T score and stiffness index
- calcium and vitamin D intake
- exercise level
- BMI
- number of holidays per year outside of UK

Following this, differences in BMD between pre- and postmenopausal participants were looked at, using either independent t tests or Mann Whitney U tests. Then, the factors listed above were tested again specifically looking within the postmenopausal group due to the risk of osteoporosis being greater after the menopause.

Finally, either Pearsons Correlation or Spearman's rho tests were performed, depending on whether the data was normally distributed, to determine:

- whether calcium and vitamin D intake had an effect on BMD
- whether BMI had an effect on BMD
- whether exercise had an effect on BMD
- whether number of holidays per year had an effect on BMD

within the postmenopausal females.

Results

337 women participated in this observational study, 282 were Caucasian and 41 were SA. The age of Caucasian participants ranged from 20 to 86 years, compared to 20 to 65 years for SA participants. This led to the mean age of Caucasian participants being significantly higher than SA participants, shown in Table 1.

Table 1 Characteristics of all Caucasian and South Asian participants

	Total Caucasian (*n* 282)		Total SA (*n* 41)		
Variable	Mean	SD	Mean	SD	*P* Value
Age (years)	51	15.0	34	11.5	<0.001**
T Score	-0.7	1.1	-0.6	1.3	0.44**
Stiffness Index	89.4	17.7	90.7	20.1	0.47**
Ca Intake (mg)	740.7	386.5	564.7	361.3	<0.001**
Vit D Intake (µg)	2.5	3.8	3.2	9.0	<0.001**
BMI (kg/m^2)	26.4	5.3	26.9	5.0	0.26**
Exercise (times per week)	2.2	1.4	1.9	1.4	0.23**
Holiday outside UK (times per year)	1.2	1.1	0.8	0.6	0.04**

SA, South Asian; SD, Standard Deviation; Ca, Calcium; Vit D, Vitamin D; BMI, Body Mass Index; UK, United Kingdom.

* P Value obtained by t test

** P Value obtained by Mann Whitney U Test

As can be seen in Table 1, the mean values for the T score and stiffness index were actually higher in the SA group, however they were not significantly different to the Caucasian group. The mean T scores for both groups were within the category of normal bone mass, i.e. above -1. However, the lowest score for the Caucasian females was -3.8 compared to -4 for the SA females and the highest score for the Caucasian females was 3.5 compared to 1.7 for SA females. Although the mean T score for the SA participants was slightly better than the Caucasian participants, their lowest readings were lower and their highest readings were not as high as the Caucasian women.

There were significant differences for daily calcium and vitamin D intakes, Caucasian participants consuming significantly more calcium (740.7mg vs 564.7mg, $P<0.001$) but less vitamin D (2.5µg vs 3.2µg, $P<0.001$) than SA participants. The Caucasian participant's calcium consumption was above the recommendation of 700mg, however the SA participant's was below. Although the SA women had a slightly higher BMI when compared to the Caucasian women ($26.9kg/m^2$ vs $26.4kg/m^2$), this difference was not significant ($P=0.26$). There was however a significant difference in the number of holidays per year outside the UK, Caucasians travelling abroad more often than SAs (1.2 times vs 0.8 times).

Differences in bone density readings between all pre and postmenopausal participants were looked at with significant differences between them both (P<0.001). The T score and stiffness index were significantly lower in the postmenopausal females compared to the premenopausal females (-1.0 vs -0.3 and 84.0 vs 94.5 respectively). This is shown in Table 2. Characteristics of specifically the postmenopausal participants were analysed which is shown in Table 3.

Table 2 Differences in bone mineral density between all pre and postmenopausal participants

	Total pre. (*n* 172)		Total post. (*n* 151)		
Variable	Mean	SD	Mean	SD	*P* Value
T Score	-0.3	1.1	-1.0	1.0	<0.001*
Stiffness Index	94.5	17.8	84.0	16.6	<0.001*

Pre, pre-menopausal; post, post-menopausal; SD, Standard Deviation.

* P Value obtained by t test

** P Value obtained by Mann Whitney U Test

Table 3 Characteristics of postmenopausal participants

	Post. Caucasian (*n* 144)		Post SA (*n* 7)		*P* Value
Variable	Mean	SD	Mean	SD	
Age (years)	62	8.4	51	9.8	0.005**
T Score	-1.0	1.0	-1.0	1.6	0.98*
Stiffness Index	84.0	16.1	83.4	26.1	0.93*
Ca Intake (mg)	726.2	325.1	530.1	214.2	0.11**
Vit D Intake (µg)	2.9	4.4	0.7	0.7	0.05**
Exercise (times per week)	2.3	1.3	2.6	1.8	0.52**
BMI (kg/m^2)	27.2	5.2	30.5	4.4	0.05**
Holiday Outside UK (times per year)	1.2	1.1	1.0	0.6	0.96**

Post, post-menopausal; SA, South Asian; SD, Standard Deviation; Ca, Calcium; Vit D, Vitamin D; BMI, Body Mass Index; UK, United Kingdom.

* P Value obtained by t test

** P Value obtained by Mann Whitney U Test

The postmenopausal SA participants were significantly younger than the postmenopausal Caucasian participants (P=0.005). There were no significant differences in the mean T score or stiffness index between the postmenopausal Caucasian women and the postmenopausal SA women (P=0.98 and 0.93 respectively). The mean T score for both groups was -1 which was exactly on the border of normal bone mass, i.e. -1 and above. The lowest T score for the postmenopausal Caucasian women was -3.8 compared to -3.5 for the postmenopausal SA women, however the highest T score for the postmenopausal Caucasian women was 2 compared to only 1.6 for the postmenopausal SA women. Table 4 shows the proportion of participants within each category of T score. Although there was a higher percentage of postmenopausal SA females within the normal bone mass category, there was

also a higher percentage of postmenopausal SA females within the osteoporosis category, when compared to the postmenopausal Caucasian females.

The postmenopausal Caucasian participants were above the recommendation for calcium, however the postmenopausal SA participants were under. Although the postmenopausal Caucasian females consumed more calcium than the postmenopausal SA females (726.2mg vs 530.1mg), this difference was not significant (*P*=0.11). The vitamin D intake however was significant (*P*=0.05), again with Caucasian participants consuming a higher amount (2.9µg vs 0.7µg). There were no significant differences in the amount of exercise per week or holidays outside the UK between the two postmenopausal groups (*P*=0.52 and 0.96 respectively), however the postmenopausal SA participants had significantly higher BMIs than the postmenopausal Caucasian participants (30.5kg/m^2 vs 27.2kg/m^2, *P*=0.05). This resulted in the mean BMI of postmenopausal SA participants falling into the obese category, i.e. above 30kg/m^2 whereas the mean BMI of postmenopausal Caucasian participants falling into the overweight category, i.e. 25 – 30kg/m^2.

Table 4 Proportion of participants in relation to T scores

		Post. Caucasian (*n* 144)	Post SA (*n* 7)
Category	T Score	Percentage	Percentage
Normal bone mass	-1 or above	49	57
Low bone mass (osteopenia)	between -1 and -2.5	47	29
Osteoporosis	below -2.5	4	14

Post, post-menopausal; SA, South Asian.

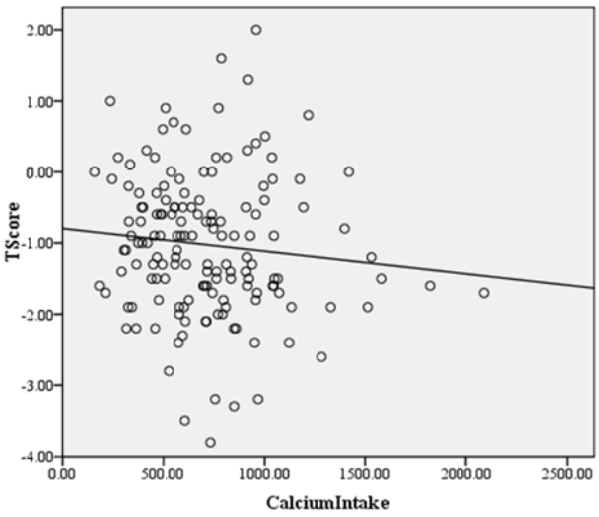
As can be seen in Table 5, there were no significant or strong relationships between any of the lifestyle factors and the T score or stiffness index. Although they were small, each factor had a positive effect on BMD apart from calcium intake which appeared to have a slight negative effect on the T score and stiffness index, this is shown in Figure 1.

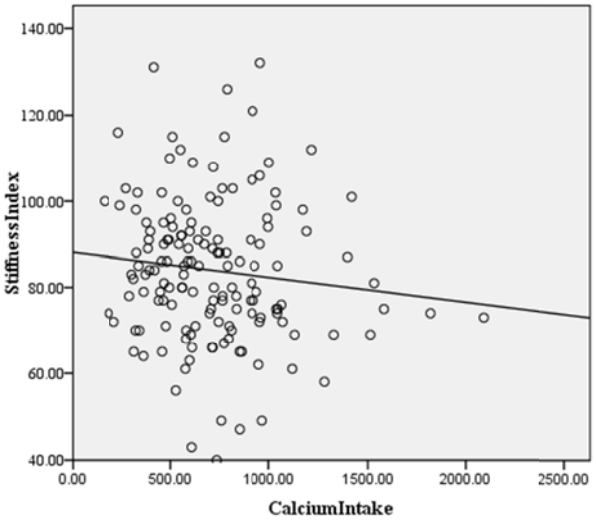
Table 5 Effect of lifestyle factors on BMD

	T Score		Stiffness Index	
	P Value	r Value	P Value	r Value
Ca Intake	0.13**	-0.12**	0.12**	-0.13**
Vit D Intake	0.32**	0.08**	0.22**	0.10**
Exercise	0.33**	0.08**	0.42**	0.07**
BMI	0.12**	0.13**	0.19**	0.12**
Holiday outside UK	0.19**	0.12**	0.34**	0.08**

Ca, Calcium; Vit D, Vitamin D; BMI, Body Mass Index; UK, United Kingdom.

* Value obtained by Pearsons Correlation





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Value obtained by Spearman's rho

Figure 1 Relationship between calcium intake and T score and stiffness index

Discussion

The aim of this study was to assess whether there were any differences in BMD and the risk factors associated with osteoporosis between postmenopausal Caucasian and SA women living in North West England. Indo-Asian immigrants are known to be at a high risk of metabolic bone disease (Mehta, Taylor, Petley, Dennison, Cooper, & Walker-bone, 2004) due to a number of factors such as diet, vitamin D levels and other lifestyle influences. Postmenopausal females were studied because osteoporosis is one of the major concerns after the menopause due to the decreased amount of oestrogen. Oestrogen facilitates the uptake of calcium from the blood into bone. A fall in oestrogen levels therefore leads to a fall in BMD. The results from this study showed a significant difference in T score between the premenopausal and the postmenopausal participants. This demonstrates how important it is to target other risk factors, in order to reduce the occurrence of this condition in not only Caucasian but also SA females.

Calcium is the most important mineral for bone health. However, the results of this study revealed a slight negative effect of increasing calcium on T score within the postmenopausal females. However, this was most likely due to errors in reporting dietary intake with the 24 hour recalls. As it was only the diet from the previous day, this may have not been a true representation of the normal calcium intake. Also, due to the way in which this trial was carried out, there was often a large number of participants attending for measurements simultaneously. To ensure the study ran smoothly and to reduce waiting time, 24 hour recalls were often self-completed. Therefore drinks were not always noted which could have had an effect on total calcium intake, for example milk in tea or coffee was missed. Although there was no significant difference between the two communities in calcium intake, it can be seen that the postmenopausal Caucasian women consumed a higher amount than the postmenopausal SA women. The SA women were also under the recommended intake of 700mg/day. This is a finding consistent with other studies, for example, Lowe, Mitra, Foster, Bhojani and McCann (2010) reported mean dietary calcium intake of their Indian participants was low (Lowe, Mitra, Foster, Bhojani, & McCann, 2010) and Vyas et al. (2003) found that calcium intakes were lowest in the Pakistani group of their study (Vyas, et al., 2003). Calcium intakes may be low among this community as up to 90% of SAs are thought to be lactose intolerant (http://www.pamf.org/southasian/ risk/concerns/lactose.html). Also in this study, taking breakfast as an example, most Caucasian women consumed cereal with milk, whereas SA women tended to consume toast. Also, due to the months in which the measurements were taking place, many SA women were fasting due to Ramadan. This may have also affected their calcium intakes.

Vitamin D aids the absorption of calcium and a small amount can be obtained through diet in foods such as fatty fish, eggs, meat and fortified foods including yoghurts, breakfast cereals and margarine (DoH, 1991). In this study however, vitamin D intake had very little effect on the T score. Despite this, the postmenopausal Caucasian females consumed a significantly higher amount of vitamin D compared to the postmenopausal SA females. The majority of vitamin D is obtained through exposure to sunlight, however for SAs, increased skin pigmentation plus traditional concealment of the body with clothes, reduces their ability to synthesise this vitamin (Islam et al., 2010). The UK population in general may be at risk of hypovitaminosis as inhabitants of countries above 37°N do not synthesise vitamin D during winter and the UK is above 51°N (Lee et al., 2008). However there was not a significant difference in the number of holidays outside of the UK between the two communities and this had very little effect on the T score.

Regular weight bearing or resistance exercises are also essential for bone health as bones adapt their structure as a response to stress increasing cortical thickness and strength (Roush, 2011). However, Fischbacher, Hunt and Alexander (2003) reported that levels of physical activity are lower among SA than the general population in the UK (Fischbacher, Hunt, & Alexander, 2003). This may be because many SA women have certain barriers to physical activity. These include working long antisocial hours, taking time out for themselves to go exercising being interpreted as selfish and culturally inappropriate, cultural issues around exposing their bodies to members of the opposite sex, and not being socialised into spending time outdoors and participating in sports when they were younger (Lawton et al., 2006). In this study, although the postmenopausal SA women participated in exercise less often than the postmenopausal Caucasian women, the difference was not significant.

Obesity may be protective against osteoporosis as fat mass has a beneficial effect on increasing bone mass (Zhao et al., 2008). This is also shown in this study as BMI had a small positive effect on the T score. However, this can cause major other health problems such as type 2 diabetes, coronary heart disease, cancer and sleep apnoea (Garrow, James, & Ralph, 2000). Obesity can also affect the form in which vitamin D is stored which can lead to insufficiency. In this study there was a significant difference between the two communities in BMI, the SA participants having a higher mean score and entering the obese category with a value of 30.5kg/m^2. This is also a finding of other studies as Bush, Williams, Lean and Anderson (2001) commented that SAs are often overweight (Bush, Williams, Lean, & Anderson, 2001). This may be due to a Westernised diet. According to Lawton, Ahmad, Hanna, Douglas, Bains and Hallowell (2008), the SA pre-migration diet which contained little meat and dairy products and large amounts of chapattis and rice, pulses, fruit and vegetables, has evolved into one with a higher fat, sugar and calorific content (Lawton,

Ahmad, Hanna, Douglas, Bains, & Hallowell, 2008). Lawrence et al. (2007) also found that Pakistani and Bangladeshi women felt their diet had become less healthy after adopting the 'worst of the British diet' (Lawrence et al., 2007). In this study, many SA participants recalled eating chocolate, crisps, biscuits and chips as well as many consuming two large main meals a day.

The main aim of this study was to investigate differences in BMD between postmenopausal Caucasian and postmenopausal SA women, however no significant differences were found. This may have been due to a number of factors. The postmenopausal SA women were significantly younger than the postmenopausal Caucasian women therefore age may have affected results. Also, many of the SA participants had already been prescribed vitamin D tablets by their doctor which may have improved their BMD. Other limitations of this study include the number of participants from each community, i.e. more Caucasian women than SA women. Although the number of Caucasian participants was greater than the desired sample size given by the power calculation, the number of SA participants was much lower. This may have affected the results. However, due to the months in which this study was carried out, Ramadan affected the recruitment of SA women as many community centres were closed. Also deadline restraints limited the amount of time allowed for enrolment onto the study. There also may have been errors from 24 hour recalls due to under-reporting and also self-completion by participants. Some women also struggled to remember what they had to eat the day before which could have led to mistakes. Also this may have not been a true representation of a typical diet as it was only one day. A more reliable method would have been a 7 day food diary in which a mean daily intake could have been calculated. However due to the form in which this study was carried out this was not possible as participants attended a one off session. It is also known that although the Achilles Insight is a good estimation of BMD, the 'gold standard' measurement is considered to be from a dual-energy x-ray absorptiometry (DEXA). However, also due to the way in which this study was carried out it was more convenient to use the Achilles Insight as it was portable and could be taken to various community centres, rather than participants having to attend a hospital or clinic for a bone scan.

In this study, although no differences in BMD were found between Caucasian and SA females, significant differences were observed between pre and postmenopausal participants. This is valuable as it supports the evidence that BMD decreases after the menopause and shows the importance of targeting other risk factors associated with this condition such as low calcium and vitamin D intake, low exercise levels and low vitamin D levels.

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