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Comparison of Vitamin D Status among Healthy Women of Lahore and Islamabad with respect to Air Quality Index (AQI)

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Abstract

It explores the effect of air pollution in affecting vitamin D deficiency in apparently healthy women in Pakistan, especially based on the relationship between air quality and vitamin D concentration. Since it has been proposed that poor quality air negatively affects Vitamin D, this study assesses this correlation in women from areas with high pollution compared to those with low pollution. Cross-sectional research data were collected by purposive sampling from 100 female participants in the postmenopausal group and aged years with no known chronic diseases, pregnancy, or factors that may affect vitamin D levels. The participants were recruited from Lahore and Islamabad and were divided by the level of pollution in these cities. They completed the demographic sheet, a questionnaire about sun exposure, a blood test for vitamin D, and a food frequency questionnaire. We obtained PM 2.5 levels for each place's air pollution exposure by cross-correlation of data from the US Consulate Pakistan Nowcast algorithm. Here, lower vitamin D status was significantly and negatively associated with pollution levels, which revealed that women living in areas with high pollution are more likely to be affected by the deficiency. The acquisition of data was cleared by both Nur International University and the National Hospital Institutional Review Boards. According to the results of the study, there is a high correlation between air quality and vitamin D levels in healthy women in Lahore and Islamabad. Using an independent sample t-test on the data, we determined that vitamin D mean levels are significantly different ($p < .05$) in the two cities, which supports the hypothesised link between air pollution and vitamin D deficiency.

Introduction

Vitamin D is one of the few vitamins that require intake because, unlike other microelements and trace elements, they should be consumed with food. It is produced internally when the skin is exposed to sunlight but can also be ingested and supplemented. Just adequate amount of insolation exposure during the cutaneous synthesis of vitamin D can help an individual's body meet 80–100% of their daily requirement of the vitamin. Vitamin D is mainly categorized into two big divisions, such as cholecalciferol and ergocalciferol.When yeast sterol is irradiated by UV light, it forms Vitamin D2. This vitamin naturally exists in the sunlight-grown mushrooms. Mackerel, salmon, and herrings that are rich in oil are sources of vitamin D3, and cutaneous synthesis occurs

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through UVB-mediated photolysis. The vitamin D3 available in stores is synthesized via 7-dehydrocholesterol, also referred to as lanolin, from skin cholesterol (Trehan et al., 2017).

More specifically, there is an increasing problem of vitamin D insufficiency, primarily because few natural food sources are available for this nutrient. Fortified foods even do not deliver adequate qualities to fulfill the need of an adult or any child. This is a problem exacerbated by poor gut uptake of dietary vitamin D, especially in the context of limited access to medical check-ups and registered dietitian services, which is the case in Pakistan. States like obesity, malabsorption syndrome, nephrotic syndrome, and post-bariatric surgery only add to the vitamin D-deficient states (Kurt et al., 2010). High levels of UVB rays cause skin cells to transform 7-dehydrocholesterol into pre-vitamin D3. This precursor undergoes a two-step hydroxylation process before its physiological activity is realized. The enzyme D-25-hydroxylase operates in two pathways, one of which includes liver hydroxylase and the other includes kidney hydroxylase. The liver transforms vitamin D into twenty-five hydroxy IG(OH)LD, which is a crucial intermediate, and the second process occurs in the kidneys, where 25(OH)D is further hydroxylated using the 25(OH)D-1,25-OHase enzyme to form 1,25-dihydroxyvitamin D or calcitriol (1,25(OH)2D). Calcitriol, the last product, is used in the regulation of calcium balance or imbalance, bone health, and immunological effects (De Luca et al., 2004).

Vitamin D enhances immunological well-being, calcium and phosphorus absorption, as well as bone health. It is an important vitamin, and it plays a role in almost all aspects of human health and performance. In particular, when the amounts of vitamin D are low, the capacity of the human organism to incorporate calcium and phosphorus is significantly restricted. The absorption of dietary calcium stands at 10–15 percent, and phosphorus stands at around 60 percent; therefore, this is a deficit. This insufficiency results in high serum parathyroid hormone levels, which, contrary to the lack of calcium in the blood, increases reabsorption of calcium in the tubules of the kidney. However, this compensatory mechanism has its cost of allowing some degree of degeneration in the bones and increased vulnerability to fractures. Chronic deficiency leads to a condition known as osteoporosis, where the bones become brittle and are as airy as a sponge. On the other hand, sufficient vitamin D intake eliminates this risk, as it increases calcium absorption by as much as 30 to 40 percent and phosphorus by 80 percent (Holick et al., 2011). It is evident that a shortage in vitamin D has some serious effects on the health of women, despite that of men. It is a major cause of rickets in children and plays a major part in osteopenia, osteoporosis, fractures, and other orthopedic disorders in adults. Contrary to what people believe that if one takes a high-quality diet, one is assured of adequate vitamin D, most foods, including powdered milk and dairy products fortified with vitamin D, have very low amounts. None of the various types of fish is sufficiently rich in these Omega-3 fatty acids except for fatty fish, which are naturally rich in them.

To understand how to prevent deficiency, it can be important to also read the nutrition facts label, to be aware that not all food with dairy as an ingredient would contain added vitamins, and matters such as considering supplements or other sources of the vitamin. Talking with healthcare professionals and registered dieticians can solve problems with vitamin D and improve overall health (Kurt et al., 2010). Thus, the use of vitamin D obtained from foods or by synthesis in human skin depends on certain factors, including the fat stores in the body and enzymatic processes. Oral consumption of vitamin D is made up of two types of vitamin D: There is cholesterol Children D3, which is obtained from vertebrates, and vitamin D2, also known as ergocalciferol, which is obtained from invertebrates like plants, fungi, and others. Vitamin D2 and D3 have similar molecular designs; therefore, both have been effectively used for the treatment of osteomalacia, rickets, and hypovitaminosis-D (Holick et al., 2008). It looks for this nutrient on a dose-dependent inverse relationship with mortality, several types of cancer, auto-immune diseases, hypertension, cardiovascular diseases, diabetes, and several viral illnesses. Breast, prostate, and colon malignant tumors are understood directly to vitamin D-binding protein, or VDBP.

Low vitamin D levels also seem to determine the activation and liberation of pro-inflammatory

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cytokines, which increases the risk of cardiovascular disease by affecting endothelial dysfunction and stiffness of the atrial walls. It is required to achieve a blood level of 75 nmol/L or 30 ng/mL for 25-hydroxyvitamin D to have added health value. If children and adults do not get enough sun exposure, they would require approximately at least 8-10 mcg of Vitamin D3 daily. When given at physiological doses, vitamin D2 might be just as effective in maintaining blood concentrations of 25-hydroxy vitamin D (Michael et al., 2008).

A major deficiency studied in society today, vitamin D insufficiency, is a health deficit that is present in a large part of the global population. According to the study conducted by Riaz et al., 53.5% of Pakistanis are suffering from vitamin D deficiency, whereas 31.2% of the population of Pakistan has low levels of vitamin D. Recent topics of scientific study include the impact of vitamin D deficiency and its relation to increased female fertility and growth and development of uterine leiomyoma. This also shows just how urgent it is to address Pakistan's vitamin D deficiency because its effect is so widespread when it comes to health conditions. The use of vitamin D supplements appears to be a logical and effective strategy for the prevention and management of many metabolic diseases and diseases in the global village, particularly in Pakistan, since the indication is that many people in Pakistan have low levels of vitamin D. In this way, contributing to a reduction of the impact of vitamin D deficiency on health, these supplements have a significant role in the promotion of the population's health and quality of life (Arif et al., 2023).

Effects of particle air pollution or acid precipitation on circulating concentrations of 25-hydroxyvitamin D [25(OH)D] in pregnant women are examined in a prospective cohort study involving 3285 pregnant women at a maternity and childhood hospital. The outcomes of this study were serum 25(OH)D levels, and no interventional procedures were undertaken. In the context of their work, the investigators established a trimester-specific relationship between serum 25(OH)D levels and exposure to particle air pollution. These relations were most pronounced during the entire pregnancy and particularly during the third trimester. Specifically, we found that with a 10 mg/m3 increase in PM2.5 and PM10, which are the particulate matter with an aerodynamic diameter of 10 or smaller, 25(OH)D levels were reduced by 4.62 percent and 5.06 percent, respectively. Altogether, our study suggests that prenatal exposure to particle air pollution could be a contributing factor to maternal vitamin D deficiency (Alshahrani). Vitamin-D deficiency has now become a worldwide issue that cuts across age, sex, and geographical distribution. Although it is highly prevalent, it is still largely unnoticed and neglected, especially in clinic settings. It remains a major undiagnosed and untreated nutritional deficiency that warrants more awareness. A number of previous studies assessing vitamin-D status have classified deficiency employing diverse thresholds, with a pool of 25(OH)D of below 20 ng/mL being standard.

These studies again and again demonstrate that deficiency of vitamin D is very much a part of the Indian population. These include trends in sedentary lifestyles and reduced exposure to sunlight due to urbanization, the effects of environmental pollution that hinder penetration of UV rays, thereby hindering the synthesis of vitamin D, low consumption of calcium- and vitamin-D-bearing food products, increased use of sunscreen lotions, and culturally sensitive factors such as wearing the burqa and purdah. More so, unwanted pregnancies for women with poor dietary habits worsen vitamin D deficiency to the detriment of both the mother and the child. This silent epidemic of vitamin D deficiency in India starts putting a lot of burdens on the development and health care system of the country. Actually understanding the various implications of vitamin D deficiency, it cannot be overemphasized that this area must be tackled holistically and without delay. The improved targeted purposes, increased consciousness, and the strengthening of the nation's public health are measures required to help narrow down the disastrous consequences of vitamin D deficiency on the nation's health.

Lack of vitamin D is especially hazardous to the elderly. Both genetics, lifestyle choices, sun exposure, and degree of which vitamin D from food might influence an individual's vitamin-D status. 2,857 older adults aged 65 and over were enlisted for a study on the primary factors that

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determine the vitamin-D status and the degree of importance in an older Dutch population. Serum levels of 25-hydroxyvitamin D were estimated in these subjects. Self-administered structured questionnaires were employed to acquire information relating to sun exposure; food frequency questionnaires were employed to assess vitamin-D content in foods consumed; resultingly, four particular genes were used to acquire genetic information concerning 25(OH)D. Regarding this, 45% of the subjects had their serum 25(OH)D less than 50 nmol/L, while only 6% of the subjects were consuming vitamin-D supplements. The strong and positive association shows that those sun and supplemental vitamin D are major determinants of 25OHD status. As demonstrated in this study, it is possible to predict approximately one-third of the variability in 25OHD status based on the factors tested. According to Brouwer-Brolsma and her team, the parameters of sun exposure ranked highest in the consideration of serum 25(OH)D levels in the senior adults, and this was quickly followed by genetic variables coupled with dietary vitamin D intake (2016).

A cross-sectional study was depicted for the Egyptian women of various age groups to find out the extent of their vitamin D. Total participants were 404, and all the participants were divided into 5 groups. The participants who were selected were as follows: group 1 had 51 samples of lactating mothers, group 2 had 50 samples of pregnant women, group 3 had 208 fertile women, group 4 had 38 samples of women who were senior citizens, and group 5 had 57 samples of old women. The participants answered a self-structured questionnaire regarding sociodemographic data and dietary intake, particularly vitamin C, D, and calcium. Moreover, some laboratory investigations, such as calcium, phosphorus, PTH, and vitamin ? D, were investigated in a laboratory setting. 75% of lactating mothers had deficiency of vitamin D, while 54% of pregnant women in group 2, 72% of the childbearing age in group 3, 39.5% of old aged women in group 4, and 77.2% of the grandparenthood age group of women in group 5, respectively, were found deficient in vitamin D. Comparing the communism of the two groups, unveiled females had very different levels of vitamin D from veiled females.

The studies in this research revealed that a lower level of vitamin D is more prevalent in healthy Egyptian females (Raif M et al., 2015). Light pollution is not only a leading cause of climate change but also a great danger to the well-being of society. Together with other hazardous chemicals emitted in the contaminated air, a high risk is identified for a variety of health concerns; prominent among them is the influence of fine particulate matter on bone conditions. New studies carried out have shown a strong link between bone diseases such as osteoporosis and air pollution. Hypoestesia: these are factors that cause the deterioration of bone mass density; they include age, sex, low BMI, lack of physical activity, postmenopausal status, chronic kidney disease, alcoholism, tobacco smoking, malnutrition, and diabetes. Inexplicably, one of the novel factors that have been associated with osteoporosis is actually air pollution. Research has suggested that the following effects of particulate matter found in air pollutants: hence, inflammation leads to arthritis and heart diseases together with airway inflammation. Tumor necrosis factor-alpha (TNF-alpha), Interleukin-1 (IL-1) and Interleukin-17 stimulate osteoclasts that lead to bone resorption—the breakdown of bone tissue. Also, the study established a positive relationship between the levels of exposure to PM2.5 and PM10 and the nuclear factor-kappa B pathway that enhances bone loss further in this case.

Moreover, let me also add that there are still many exacerbations of diseases and airborne problems that impact respiration and synthesizing of vitamin D, which is a very important nutrient to support bone health. When people continue to breathe in particulate matter, kidney processes that actively convert inactive 25-hydroxyvitamin-D into the active form 1,25-dihydroxy vitamin-D are inhibited, increasing osteoporosis risk. Air pollution plays a negative role in diminishing the surface solar and UV radiation, which affect the biological synthesis of vitamin D. This paper concludes that a low level of vitamin D has frequently been identified in individuals such as adolescents and children due to the high focus of particulate matter.

Hence, air pollution has been identified as a significant risk factor for osteoporosis and effects

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the quality of the bones and vitamin D biosynthesis. Fine particulate matter of PM 2.5 has been linked to this health challenge, and studies show that focal cardiac regions of fine particles affect bone mineral density (Gupta et al., 2023). The large cross-sectional survey at West China Hospital, Sichuan University, recruited 22387 participants in total. A contemplative analysis of patients age, serum levels of parathyroid hormone PTH, total calcium, 25-hydroxyvitamin-D 25-(OH)D, gender, and date of examination were done. It continuously compares the percentage of vitamin-D status by age, gender, and appearance of how changes to the environment influence vitamin-D index. Also, studies conducted to determine risk and protective variables of vitamin D deficiency were determined using univariate and multivariate analysis regression.
As for the general population, the prevalence of vitamin D insufficiency in the research area was 42.17% based on the data. This shortage is especially true for women and young people. The research revealed a positive relationship between 25(OH) D and temperature and sun radiation. On the other hand, vitamin D is inversely correlated with air quality as measured by the Air Quality Index (AQI). Additionally, there is an inverse relationship between vitamin D and female gender and parathyroid hormone concentration (He et al., 2020).

Hypothesis
Research hypothesis:
Ho1: Vitamin D deficiency due to air pollution is a risk factor for healthy women

Rationale of Study
Air quality can have a major impact on the rise in the prevalence of Vitamin D insufficiency, which is on the rise. The link between low levels of vitamin D and poor air quality is not well supported by research. We will be able to comprehend the relationship between vitamin D insufficiency and the air quality index due to this cross-sectional investigation. This will also cover whether or not blood vitamin D levels in healthy women are impacted by air pollution.

Research Objective
1. To find out the association between Vitamin D status and air quality among healthy women

RESEARCH METHODOLOGY
Study Design:
Cross Sectional research design was used in this study to investigate the comparison of vitamin D status among healthy women of highly polluted and less polluted cities of Pakistan. Purposive sampling technique was used to gather data. The sample size was calculated based on a case-control study on the effectiveness of vitamin D supplementation allowing the researcher to compare individuals who have a specific condition in this case the status of Vitamin D in healthy women of highly polluted cities with women who do not have the condition (controls) such as the ones living in less polluted cities. A sample size of 100 women was taken and calculated using a 5% significance level and a 10% margin of error.

Inclusion Criteria:
The following criteria was included in this study:
- The single population of women were included in the study to focus on the specific gender group mentioned in the research topic
- Healthy women without any diagnosed chronic diseases or conditions that may affect vitamin D status, such as osteoporosis, renal disease, or Malabsorption disorders were taken for this research study
- Women from only Lahore and Islamabad the cities of Pakistan were taken for this purpose
- Participants who were willing to participate in the study and provided informed consent was included in the research
- Participants who were able to understand and complete the study measures in the language used in the study was included

Exclusion Criteria:
The following criteria was excluded from this study:
- Women with other chronic diseases like cancer kidney diseases, diabetes were excluded
- Pregnant and lactating women were excluded, as their vitamin D needs and

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metabolism may be different due to the demands of pregnancy and breastfeeding

- Individuals with known allergies or adverse reactions to vitamin D supplements or sun exposure were excluded
- Women who were unable to provide informed consent were excluded from the study
- Depending on the research focus women who were smokers was excluded, as smoking can negatively impact vitamin D status and could manipulate the research results
- Women with severe mental health conditions that might affect their ability to participate or adhere to the study protocol were not included

Instrumentation:

Data was collected through a demographic information sheet, a well accounted questionnaire to find out the association between vitamin D status and air quality comprising of questions about the history related to sun exposure and Lab values of vitamin D. Food frequency questionnaire was also given to the participants.

Air Quality Index

Airborne fine particulate matter, or PM 2.5 as it is frequently called since the particulates have a diameter of less than or equal to 2.5 microns, is measured to determine the level of air pollution in a given location or region. The EPA has a standard called PM 2.5. The US Consulate Pakistan employed an algorithm known as Nowcast to obtain the raw PM 2.5 data for this study.

Data collection method:

Permission to conduct this research study was first obtained from the NIU and National Hospital Institutional Review Boards when data collection began. The authorized letter was taken from Nur International University, Lahore. Data for this research was collected from OPD of National Hospital and Medical Center, Lahore

RESULT AND DISCUSSION

Population of Lahore (highly polluted) and Islamabad (less polluted)

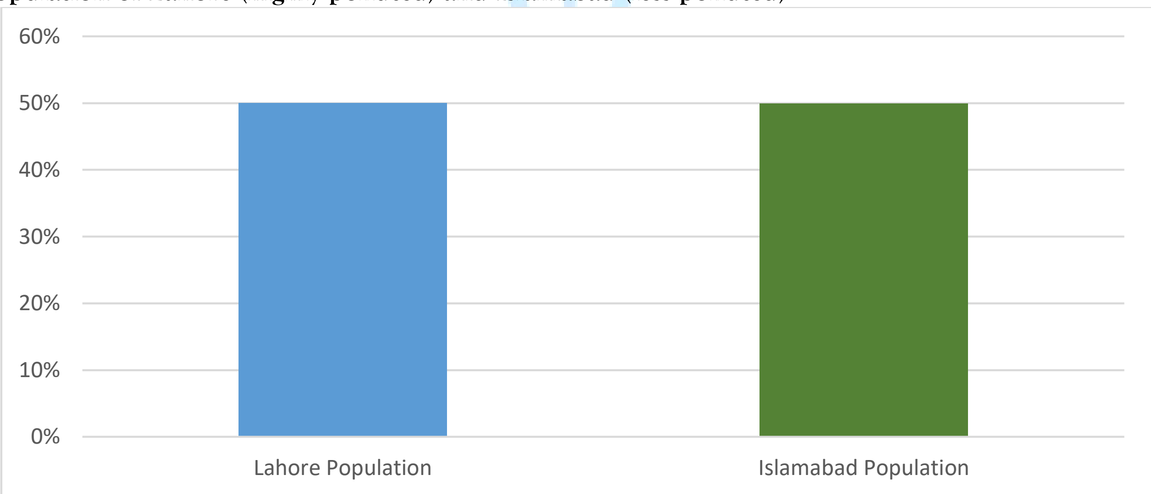

Figure 1 Distribution of population with respect to cities

The following table represents that half of the population were from Lahore and half were from Islamabad. The correlation would be fair and the results would be non-biased.

A major contributor to vitamin D insufficiency is either inadequate UVB cutaneous absorption or inadequate sunlight. To ascertain the impact of air pollution on vitamin D deficiency, a cross-sectional investigation was carried out. There were 200 free-living housewives from Tehran (a highly polluted location) and Ghazvin (a lowly contaminated neighborhood), ranging in age from 20 to 55. Participants who took medications that alter their vitamin D levels, were pregnant, or were nursing were not allowed to participate. Analysis was also done on the type of residence (villa or apartment), how much time was spent outside each week—three days or more—and how often sunscreen was used.

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Housing status of participants

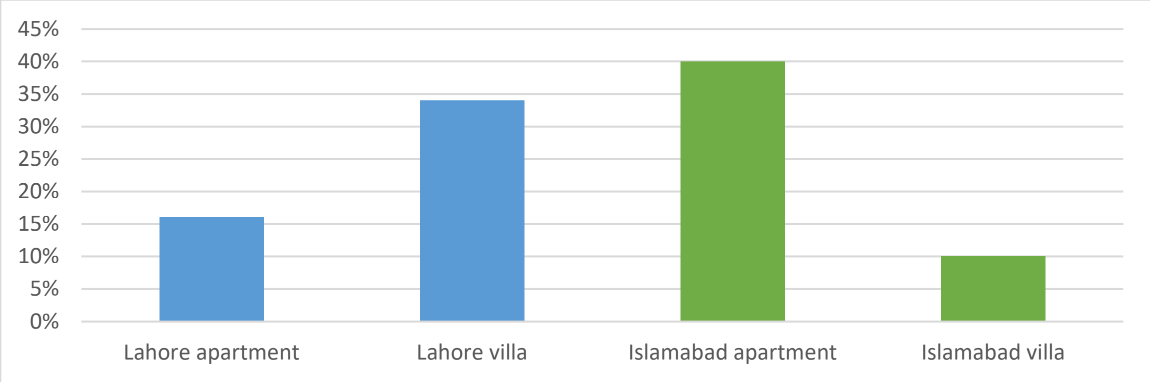

Figure 2 Housing status of selected participants from respective cities

The bar graph represents that 16% of the population of Lahore live in apartments while 34% of their population live more expanded and luminous life at villa. On the other hand 40% of Islamabad's population lives at apartments and 10% live at villas.

One of the major reasons of vitamin D deficiency is either inadequate epidermal absorption of UVB rays or inadequate exposure. To ascertain the impact of air pollution on vitamin D deficiency, a cross-sectional investigation was carried out. There were 200 free-living housewives from Tehran (a highly polluted location) and Ghazvin (a lowly contaminated neighborhood), ranging in age from 20 to 55. Participants who took medications that alter their vitamin D levels, were pregnant, or were nursing were not allowed to participate. Analysis was also done on the type of residence (villa or apartment), how much time was spent outside each week—three days or more—and how often sunscreen was used. Ghazvinian women had a considerably higher mean ± SD of serum 25-OH-D. Tehranian group had higher incidence of 25-OH-D between 10 and 20 ng/ml and less than 10 ng/ml (Hossenpanah et al.,2010).

Time Spent Outdoor by Participants

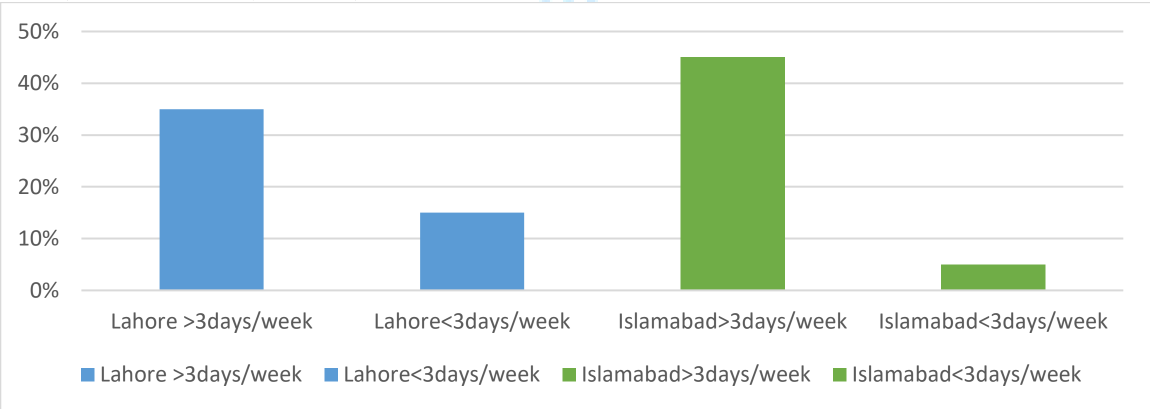

Figure 3 Time spent outdoor by participants in their respective cities

Around 35% people from Lahore spend >3days/week outdoor and 15% <3days/week spend outdoor on the other hand 40% people from Islamabad spend >3days/week outdoor and 5% <3days/week spend outdoor.

This pilot study compared the ways in which diet and sun exposure practices affect vitamin D levels in young adults 18–40 years of age and older adults 65–89 years of age in the United Kingdom. A history of one week of vitamin D intake, a questionnaire evaluating sun exposure and photoprotective behaviour, and a plasma 25(OH)D measurement were completed by 13 young and 11 elderly individuals. Our data disprove the widespread assumption that vitamin D status decreases with age. Compared

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to younger adults, older persons used sunscreen similarly, during the summer working week they usually spent their time outdoors, and had more summer and winter vacations. Furthermore, compared to young individuals, older persons had a substantially higher intake of food that are rich in vitamin D (Borecka et al.,2021).

Use of Sunscreen by Participants

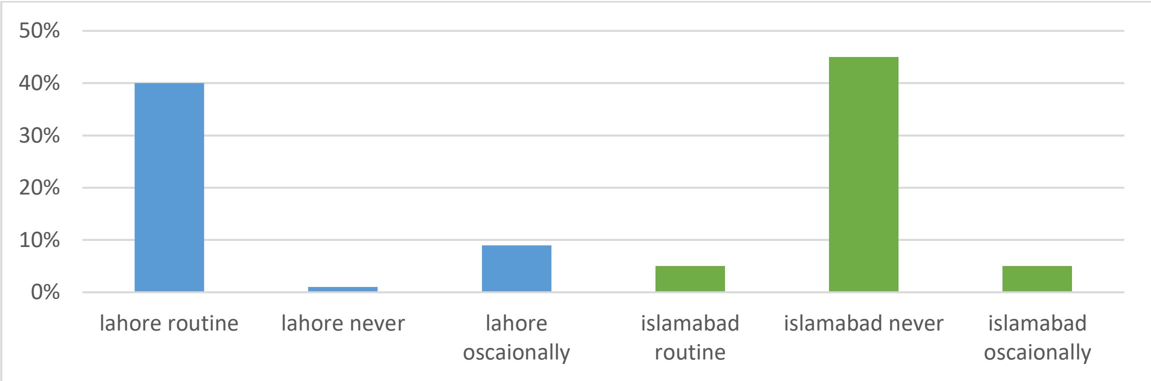

Figure 4 shows the use of sunscreen by participants in their respective cities

40% people from Lahore are choosing to wear sunscreen, 1 or 2% never really wears any and 10% are occasionally wearing sun screen likewise only 5% of population of Islamabad are wearing sunscreen in routine and 5% occasionally while a major population of 45% does not wear any sunscreen.

Vitamin D3 production on the skin is triggered by UVB light from the terrestrial range and can be attained with suberythemal exposure to a comparatively low BSA. For unintentional sun exposure, daily sunscreen use is primarily dependent on products with high UVA-PF and low SPF. It's doubtful that this will affect the synthesis of vitamin D. Actually, even with consistent use of SPF > 15, the majority of research released to date have found no correlation between sunscreen use and vitamin D deficiency. In fact, some research has found a positive correlation between the use of sunscreen and 25(OH)D3, indicating that using sunscreen may result in more sun exposure. (F.Bennerd et. Al)

Participants wearing veil

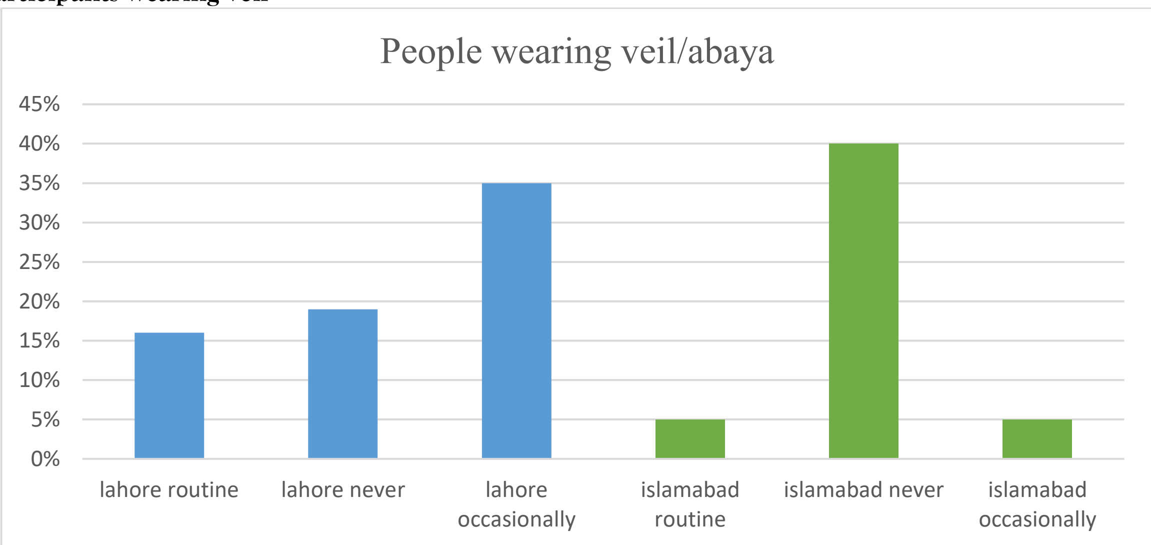

Figure 5 Participants wearing veil/abbaya in their respective cities

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These percentages shows the amount of people wearing veil/abaya in Lahore and Islamabad. More people are wearing abaya in Lahore as compared to Islamabad.

The bone mineral density BMD and vitamin D status of healthy Turkish women of reproductive age who were covered up and those who weren't were the subjects of a study. Thirty women wearing veils and thirty age-matched control subjects dressed traditionally in Western apparel took part; they showed comparable food patterns, distributions of body mass index BMI, and gestational histories. All disorders influencing bone metabolism were ruled out by physical and laboratory testing. Serum 25-OHD levels were assessed, and BMD at the hip and spine was examined using DEXA. The average age at which women began wearing veils was 15.7 ± 6.13 years, and they reported spending 66.7% of their time indoors. Vulnerably veiled women had lower levels of education and physical activity than the control group. sunlight exposure demonstrated a favourable correlation with 25-OHD, whereas veiling showed an inverse relationship. Although none of the veiled women experienced vitamin D insufficiency, their average 25-OHD concentration was comparatively lower than control group (Guzel et al., 2004).

Participants using sunscreen with SPF

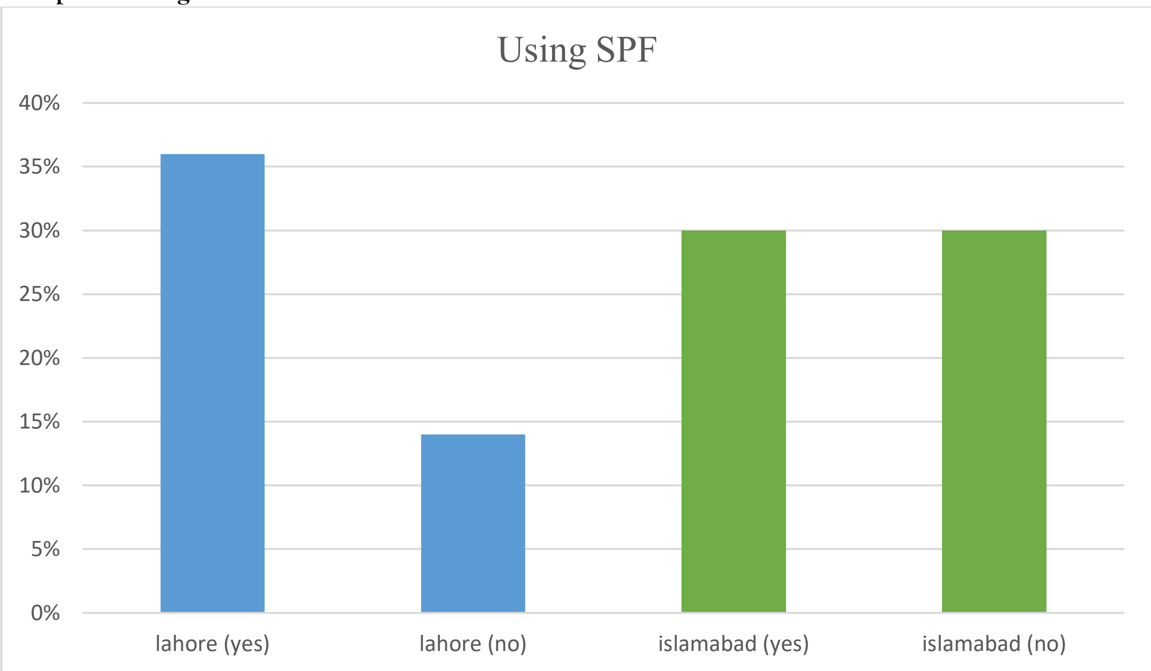

Figure 6 shows participants using skin care products containing SPF in their respective cities

Charts showing the results of people using skin products containing SPF. 35% of taken population shows they use such products on the other hand 30% population in Islamabad uses such products

Vitamin D3 production on the skin is triggered by UVB light from the terrestrial range and can be attained with suberythemal exposure to a comparatively low BSA. For unintentional sun exposure, daily sunscreen use is primarily dependent on products with high UVA-PF and low SPF. It's doubtful that this will affect the synthesis of vitamin D. Actually, even with consistent use of SPF > 15, the majority of research released to date have found no correlation between sunscreen use and vitamin D deficiency. In fact, some research has found a positive correlation between the use of sunscreen and 25(OH)D3, indicating that using sunscreen may result in more sun exposure. (F.Bennerd et al.,)

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Family History of Vit-D deficiency among Participants

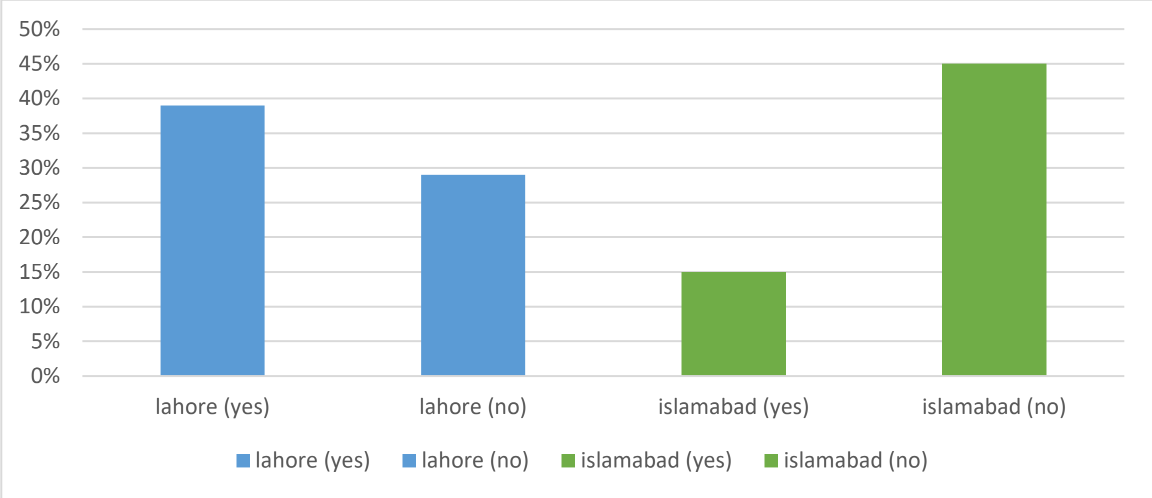

Figure 7 Vit-D deficiency and family history of participants in their respective cities

More people in Lahore suffers from vitamin D deficiency due to family history and less people in Islamabad has vitamin D deficiency due to family history.

In the northwest, there is an overall prevalence rate of 62.4% for vitamin D insufficiency disorder, according to the 580 instances of the condition that this study identified. In brothers, sisters and spouses of the patients, there was an accumulation of vitamin D deficiency. In this study, there was no evidence of a deficit accumulation in the family among other relatives, such as parents, grandparents, grandchildren, aunts, nieces, and nephews. The results suggested that some of the family members may have a cumulative vitamin D deficit. Consequently, in order to carry out early preventive intervention (Farzin et al., 2021).

Bone Related Diseases among Participants

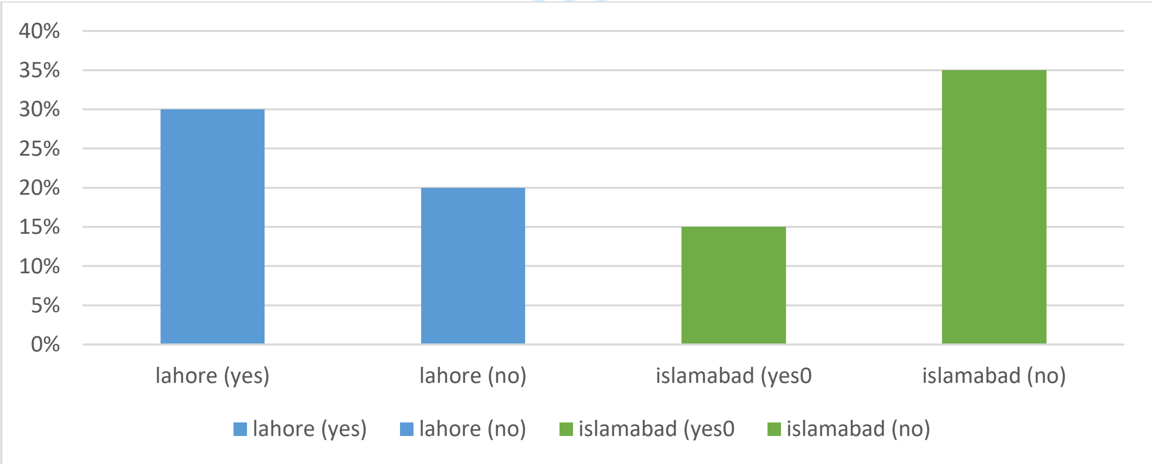

Figure 8 Distribution of Participants w.r.t. Bone related diseases

In Lahore 30% people are suffers from bone related diseases while only 15% suffers from bone related diseases in Islamabad.

Vitamin D is required for proper bone formation and maintenance. Low vitamin D levels have a negative impact on bone remodeling, osteoblastic activity, calcium metabolism, and bone density. It is well acknowledged that osteomalacia in adults is connected with vitamin D deficiency, whereas rickets is associated with vitamin D insufficiency in growing bones. Rickets is caused by a variety of diseases that produce hypophosphatemia and/or hypocalcemia, either independently or as a result of insufficient vitamin D. Osteomalacia, defined by a reduction in the mineralization

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during bone remodeling and an increased proportion of unmineralized osteoid replacing the skeleton, can be caused by a vitamin D shortage. The relationship between vitamin D and osteoporosis and bone mineral density is still up for debate, however new research suggests that vitamin D may possibly be involved (Christodoulou et al.,2013).

Digestive Issues affecting nutrient absorption among Participants

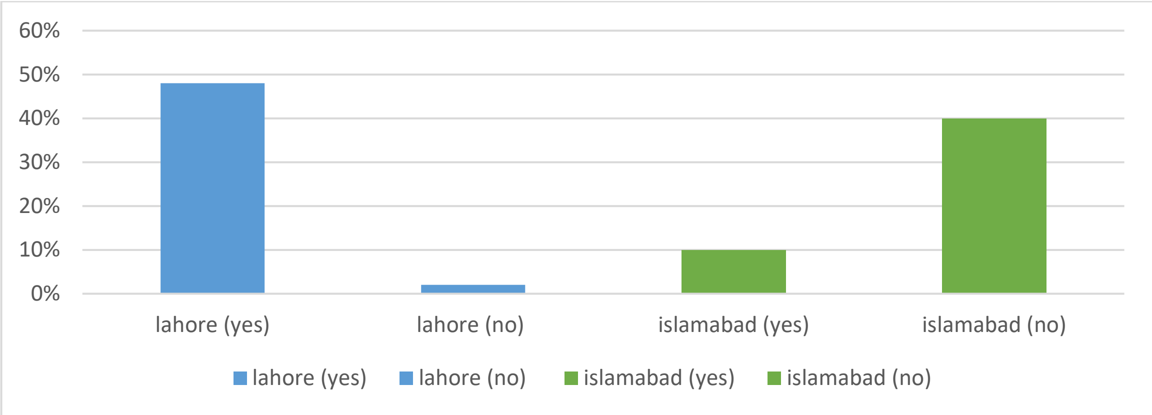

Figure 9 Distribution of participants w.r.t to their digestive issues and its impact on nutrient absorption

More digestive issues that might affect nutrient absorption such as celiac disease or irritable bowel syndrome are shown in population related to Lahore than Islamabad.

The gastrointestinal tract (GI) needs to go through multiple steps in order to properly absorb nutrients, vitamins, and minerals; these steps can all be hampered by sickness. The GI tract will use nutrition, produce energy, and expel waste when things are in good health. Nonetheless, a wide range of illnesses can affect the physiological processes that provide adequate nutrition absorption and digestion (including macro- and micronutrients), resulting in a diverse array of symptoms and nutritional implications. Understanding the mechanisms underlying poor nutrient absorption as well as the signs and nutritional implications of each individual disorder enhances the value of the roles played by a wide range of medical professionals involved in its management, including RDN, family physicians, internists, gastroenterologists, and surgeons (Montoro et al., 2021).

Medications used by participants that might affect Vit. D levels

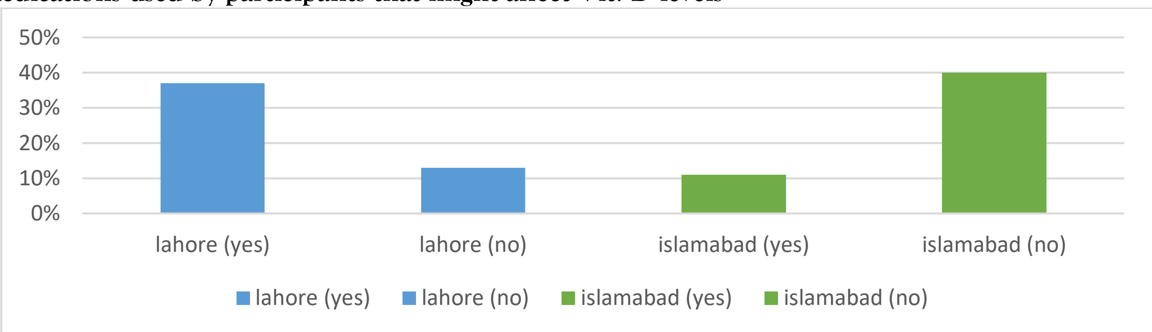

Figure 10 distribution of participants w.r.t the medication they are taking which affects vitamin D levels

More population from Lahore relies on medications that might alter the vitamin D levels. On 10 to 15% from Islamabad takes any sort of medication that might affect the vitamin D rates.

Many drugs have the potential to have more side effects and to be less effective when vitamin D levels are low. The expected pharmacokinetic interactions facilitated by the pregnane X receptor (PXR) suggest that other active

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substances might also affect the PXR-VDR system, potentially leading to vitamin D deficiency. Consequently, during long-term medication, serum levels of vitamin D should usually be monitored and any deficiency corrected. It is advised to test one's vitamin D level and then take customized, personalized vitamin D supplements for supportive and preventive purposes in many illnesses and drug regimens. (Grober and others, 2012).

Vitamin D levels of participants

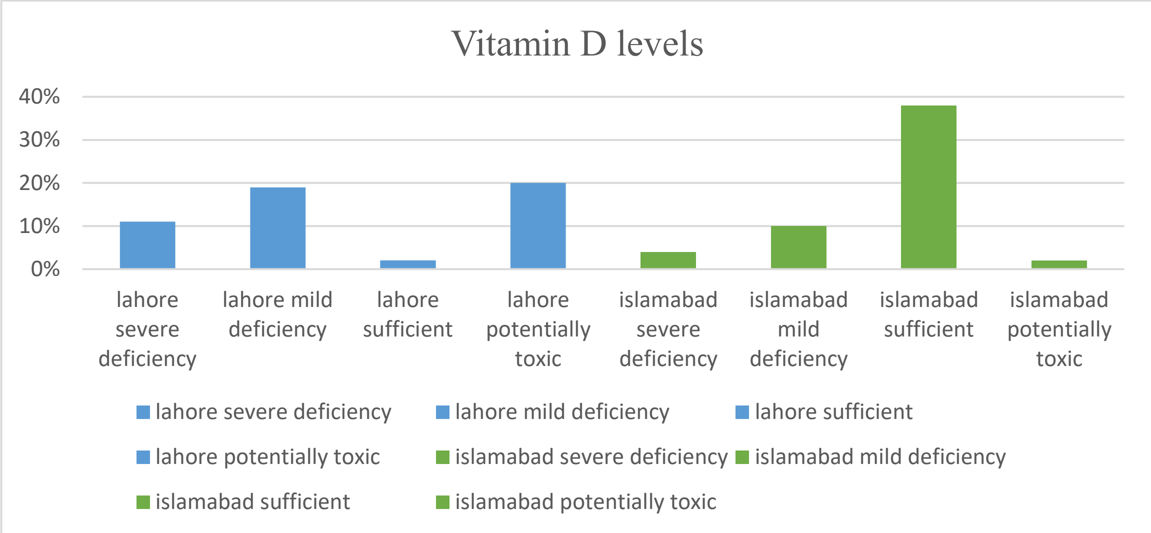

Figure 11 Participants with Vit D deficiency in their respective cities

More people from Lahore have potentially toxic vitamin D levels and sever deficiency while 35 to 40% people from Islamabad has sufficient levels of vitamin D.

Explanation of these graphs of the provided questionnaire clearly correlate and differentiate the results of population from Lahore to Islamabad. Providing evidence in supporting Islamabad and its fair conditions and less vitamin D deficiency.

The given table for air quality index is representing the correlation of air quality between Lahore and Islamabad at a specific time period of 12:00 pm at noon. These are recorded respectively to the time period and mentioned dates from both cities.

It is sub divided into some major categories or statuses such as: good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous. The results showing the average AQI for Lahore at 1/11/2023 of 338 UG/M3 which falls into the status of hazardous environment. On the other hand, for Islamabad at 1/11/2023 it was 171 UG/M3 rated as Unhealthy.

At 11/11/2023 it was recorded as 152UG/M3 unhealthy for Lahore and 70UG/M3 moderate for Islamabad. At the following dates of 12/11/2023 to 18/11/2023 the AQI was recorded as 124UG/M3, 145UG/M3, 159UG/M3, 147UG/M3, 142UG/M3, 145UG/M3, and 159UG/M3 for Islamabad rated as unhealthy for sensitive groups respectively. On the other hand, it was rated as unhealthy and hazardous for Lahore.

The airborne fine particulate matter, also known as PM 2.5 since the particles have a diameter of less than or equal to 2.5 microns, is measured by air quality sensors located around the U.S. Embassy and Consulates. A city cannot be covered by data from a single monitoring station. As a result, readings from other monitors in the same cities may differ from those obtained by the US Embassy and Consulates about air quality.

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Table 1: Descriptive Stats T-test of population of Lahore and Islamabad

Variables	Lahore		Islamabad		*t*(100)	*p*
	M	*SD*	*M*	*SD*		
I2	1.67	0.47	2.60	0.40	5.32	.00
I3	1.36	0.56	1.73	0.44	-3.64	.03
I4	1.46	0.91	1.85	0.97	-2.09	.01
I5	2.11	0.98	2.26	0.60	-0.91	.01
I6	1.46	1.01	1.38	0.49	0.45	.15
I7	1.48	1.11	1.59	0.49	-0.60	.15
I8	1.71	1.36	1.63	0.48	0.38	.09
I9	2.05	1.46	1.83	0.37	1.02	.18
I10	1.78	1.73	1.40	0.49	1.48	.12
I11	2.51	1.86	2.59	0.70	-0.25	.07

The mean value of group 1 is (1.67) and for group 2 is (2.6). Given that Levene's equality test of variance value (F=.000; p=1.000) is higher than p=0.05, the equality variance assumption is now satisfied.

Additionally, the data indicates a statistically significant difference between the groups that experience no effect from air pollution and those that experience some effect from it. Furthermore, the data also show that the mean population of Islamabad is higher than that of Lahore. As a result, hypothesis of the study is, that the people from Islamabad would have healthier liver conditions and sufficient vitamin D levels is accepted.

The analysis's findings indicate that, in comparison to women in Lahore, those residing in Islamabad enjoy superior living conditions. One of the main reasons people do not have a vitamin D deficit is less air pollution. In addition, Lahori population is more likely to suffer from vitamin D deficiency and other health issues.

One of the following cities was chosen for the research because it had better living conditions than the other, according to our study comparing the vitamin D level and air pollution among healthy women. The mean differences unequivocally show that Lahore has far more air pollution than Islamabad.

Conclusion

To wrap up the discussion by critically evaluating all the results obtained through the provided questionnaire and Air quality index statuses of two cities Lahore and Islamabad the objective we assumed "To find out the association between vitamin D status and air pollution among healthy women." we came to know that there definitely exists a relationship between vitamin D status and air pollution.

Hence our hypothesis of the study "Vitamin D deficiency due to air pollution is a risk factor" is accepted as the results obtained from independent sample t-test were showing a significant mean difference between the population of Lahore and Islamabad.

The mean value for Islamabad was less than .05 significance hence rejecting the null hypothesis. $p<.05$. The bar graphs representing each item from the questionnaire were giving significant results that more favorable conditions are in Islamabad as compared to Lahore being a major factor in causing vitamin D deficiency.

The Air quality index also suggested a fair correlation between the atmosphere of Lahore and Islamabad at a specific time 12:00pm at noon. Results have shown that at Lahore there was a great deal of unhealthy and hazardous air quality as compared to Islamabad. On the basis of these evidences hypothesis of the study is accepted.

Recommendations

For future recommendations suggestions are listed below:

- Data from more than two cities could be taken for more complex results and study
- Data from different or more than one country could also be studied
- Only a questionnaire was used to collect data for this investigation. In future studies, qualitative data may be acquired by interviewing respondents in order to gain more precise replies from participants.

- An indigenous scale should be developed according to the norms and culture of our society
- Both genders should be studied for calculating gender differences among them

Suggestions for future researchers

- The sample size of the study conducted was limited to only 100 people and therefore less chance to examine the results as a whole act as a limiting variable of this research. It is suggested that large sample size should be taken to explore the results in detail and generalize.
- Only one gender was selected, the researcher can also continue this study on both genders with their comparison.
- The study could also be cross-sectional for better validity of results capturing multiple snapshots of time.
- Establishing a correlation between vitamin D deficiency and air pollution does not necessarily imply causation. Other confounding variables, lifestyle factors, or dietary habits may contribute to vitamin D levels independent of air pollution.

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