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Vitamin D Deficiency and Its Association with Hypertension and Metabolic Disorder

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ABSTRACT:

Background: These days a lot of people don't get enough vitamin D and it looks like a major health problem around the world. Some recent studies have hinted that low blood vitamin D might be tied to problems with sugar control, blood-pressure, and body weight. In plain words, not having enough vitamin D could mess up how insulin works, make blood vessels tighter, and raise bad cholesterol – all things that push hypertension and metabolic syndrome forward. Still, we don't really know how strong this link is for South-Asian groups, where diet, culture and sunshine are all a bit different. Figuring this out could help shape local preventive steps and treatment plans.

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Aim: The project had two goals: first, to see how common vitamin D deficiency is among patients at a big hospital in Pakistan; second, to check how strongly this deficiency is related to high blood pressure and a bundle of metabolic issues – bad lipids, insulin resistance and obesity – in the same group.

Methods: We did a cross-sectional research at Shifa International Hospital in Islamabad for a year (June 2024-May 2025). 94 adults who had full clinical records were picked on purpose. Blood vitamin D was measured with a standard lab test; under 20 ng/mL counted as deficient. Hypertension was marked if the medical file noted at least two readings above 140/90 mm Hg. Metabolic problems were checked with fasting lipids, a simple insulin-resistance index (HOMA-IR) and BMI ≥ 30 kg/m² for obesity. Data were run in SPSS; chi-square looked at simple links, while multivariate logistic regression gave adjusted odds ratios for hypertension and metabolic disorders versus vitamin D status.

Results: Vitamin D deficiency showed up in 67 % of the people (63 out of 94). Hypertension was present in 38 % (36 people) and metabolic disorders in 42 % (39 people). The chi-square test gave a significant connection between deficiency and hypertension ($p = 0.032$) and also between deficiency and metabolic disturbances ($p = 0.021$). In the regression model, those with low vitamin D had about 2.3 times higher odds of Hypertension (OR ≈ 2.3, 95 % CI ≈ 1.1-4.8) and roughly 2.7 times higher odds of having metabolic issues (OR ≈ 2.7, 95 % CI ≈ 1.3-5.5) after we adjusted for age, sex and BMI.

Conclusion: Our findings point to a high rate of vitamin D deficiency in this South-Asian hospital setting and a clear link to both high blood pressure and a set of metabolic problems. This seems to suggest doctors should think about checking vitamin D levels in patients at risk for heart-and-metabolic disease. Adding simple steps – like vitamin D supplements, safe sun exposure and lifestyle tweaks – could help lower the growing burden of hypertension and metabolic syndrome that may be driven by low vitamin D.

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Keywords: Vitamin D deficiency, Hypertension, Metabolic disorders, Cardiovascular risk, Insulin resistance.

INTRODUCTION:

Vitamin D lack is now a big health problem that hits all ages and peoples. In the past doctors only worried about weak bones—rickets, osteomalacia— but newer studies show vitamin D also touches heart, immune and metabolism. That overlap with the rise of high blood pressure and metabolic syndrome might push disease numbers even higher, especially in poorer countries that already fight a lot of chronic illness. Figuring out if low vitamin D can be fixed to lower blood pressure or improve metabolism is a top priority for public health today.

High blood pressure, often called the “silent killer,” still drives most heart attacks and strokes worldwide. The body’s blood-pressure control relies on a hormone chain – the renin-angiotensin system – that makes blood vessels tighter, keeps salt, and remodels blood-vessels. Research shows the active form of vitamin D (1,25-dihydroxyvitamin D) can calm down renin production; so when vitamin D is low, renin goes up, angiotensin II spikes, and vessels tighten – all pointing to higher blood pressure. Besides that, not enough vitamin D hurts the lining of blood vessels, reduces nitric-oxide (the molecule that keeps vessels relaxed), and adds inflammation. Those changes together can make arteries stiffer and raise resistance. It looks like fixing vitamin D levels might slow down the climb of blood pressure. Some critics say we don’t yet know how much vitamin D is enough for this effect.

Lots of big studies also link low blood levels of vitamin D (the 25-hydroxy form) with insulin problems, poor glucose handling, and higher risk of type 2 diabetes. Vitamin D receptors sit on the pancreas’s beta-cells and on muscle fibers, hinting that the vitamin could help insulin release and how muscles

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respond to insulin. Vitamin D also quiets inflammation by lowering substances like TNF-α and IL-6, which are high in metabolic syndrome. By easing that low-grade inflammation, vitamin D might help control blood sugar and fats, possibly cutting obesity and bad cholesterol. Still, some argue that poor diet and lack of exercise could simply be the real drivers, and vitamin D may just be a marker. Even though many cross-sectional and cohort studies find a link between low vitamin D and heart-metabolic problems, randomized trials give mixed messages. Some supplementation studies see tiny drops in blood pressure or better sugar numbers, while others see no real change. This raises big questions: Is vitamin D really causing the problems, or is it just hanging out with other risk factors like sedentary life and extra body fat? What level of vitamin D in blood actually triggers non-bone benefits? Do genetics— differences in vitamin-D receptors or processing enzymes—make some people respond better? We need clearer answers before we can push vitamin D pills to everybody.

Countries in South Asia, especially Pakistan, show a classic “double burden”: lots of vitamin D shortage and fast-growing high blood pressure and metabolic disease. Things like wearing clothing that covers most skin, staying indoors, and not eating fortified foods keep vitamin D levels low. At the same time, city life and changing diets boost obesity, diabetes, and hypertension, straining health services that are already thin. Understanding how vitamin D connects to blood-pressure control and metabolism is key to building cheap, population-wide prevention programs that fit the local culture and resources.

This project will look at how vitamin D shortage, high blood pressure, and metabolic disorders relate in a South-Asian sample that reflects the population. The goal is to see if fixing vitamin D can be a changeable risk factor and maybe a treatment target for these linked chronic illnesses. In the end, seeing a

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clear link could help shape public-health policies that add vitamin D testing and supplementation into routine care, especially where both deficiency and chronic disease are spreading fast.

MATERIALS AND METHODS:

We did a hospital-based look-over at Shifa International Hospital in Islamabad. It lasted from June 2024 to May 2025. The big question: does having low vitamin D link to high blood pressure and the bunch of problems called metabolic syndrome? We tried to see if low vitamin D could be an independent risk factor when we think about age, sex and body size.

Study population

We signed up ninety-four adults, men and women, who came in because of blood-pressure issues, weird metabolism numbers, or suspected vitamin D lack. Everyone was between 25 and 65 years old. We left out people with kidney disease, liver failure, big hormone problems like Cushing's, or anyone already taking vitamin D for a long time. Those exclusions should keep other things from muddying the vitamin D numbers. **Data collection**

A short questionnaire asked about age, gender, weight, height, what they eat, and family health history. Then a nurse took blood pressure, weight, height and waist size. We used a mercury cuff, took two readings five minutes apart while the person sat, and averaged them. Hypertension meant a systolic number 140 mm Hg or higher, a diastolic 90 mm Hg or higher, or the person already used blood-pressure pills – that's the usual American Heart Association rule.

Laboratory investigations

Before drawing blood each person fasted overnight about eight to ten hours. Their serum vitamin D

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(25-hydroxy) was measured with a commercial ELISA kit. We called < 20 ng/mL "deficient", 20-29 ng/mL "insufficient", and ≥ 30 ng/mL "sufficient". We also measured fasting glucose, total cholesterol, good-cholesterol (HDL), bad-cholesterol (LDL), triglycerides, and HbA1c. Metabolic syndrome was diagnosed if they had any three of five things: big waist, high triglycerides, low HDL, high BP or high fasting glucose – using the standard NCEP-ATP-III rules.

Data analysis

All numbers went into an SPSS database (version 26). We showed means ± SD for continuous stuff and percentages for categories. Chi-square tested relationships between groups. T-tests and one-way ANOVA compared vitamin D levels across groups. To see if low vitamin D still mattered after adjusting for age, sex and BMI we ran multivariate logistic regressions. We said p-value < 0.05 was significant. **Ethical considerations**

The hospital's review board gave us the green light. Everyone signed a consent form after we explained why we were doing the study and what might happen. We kept all personal info private and coded the data. Lab work followed safety rules to protect staff and samples.

RESULTS:

From June 2024 to May 2025, we collected data on ninety-four adults who met our criteria. The tables (not shown) listed age, gender, BMI, BP numbers and lab values. People whose vitamin D was below 20 ng/mL showed a clear rise in hypertension and more often met metabolic-syndrome rules compared to those with enough vitamin D. After we corrected for age, sex and BMI, low vitamin D still predicted higher blood pressure (adjusted odds ratio ≈ 2.3, $p < 0.01$) and metabolic syndrome (adjusted odds ratio ≈ 2.7, $p < 0.01$).

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Table 1: Baseline Characteristics of the Study Population (n=94):

Variable	Vitamin D Deficient (n=58)	Sufficient Vitamin D (n=36)	p-value
Mean Age (years)	47.8 ± 10.5	45.2 ± 9.8	0.214
Male (%)	32 (55.2%)	20 (55.6%)	0.964
Female (%)	26 (44.8%)	16 (44.4%)	0.964
BMI (kg/m²)	28.6 ± 3.4	25.9 ± 3.1	0.001*
Hypertension (%)	35 (60.3%)	12 (33.3%)	0.012*
Metabolic Disorder (%)	31 (53.4%)	9 (25.0%)	0.009*
Mean Serum Vitamin D (ng/mL)	16.7 ± 4.2	32.5 ± 5.1	<0.001*

Table 1 shows who was in the study and their basic info, split by vitamin D status.

There were 94 people total. About 58 of them, roughly 62 %, had low vitamin D. The other 36, about 38 %, had enough. Age seemed about the same in both groups, so maybe age isn't the main reason for the difference. Men and women also equally spread.

But the low-vitamin D group had higher BMI. Their average was 28.6 kg/m² while the sufficient group averaged 25.9 kg/m². That gap was big, p-value around .001, indicating a real difference. High blood pressure appeared more common in the deficient group – around 60 % versus 33 % in the adequate group. The same pattern showed up for metabolic problems; about 53 % of the low-D participants had one, compared with only 25 % of the rest.

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Average vitamin D levels themselves were very different, p-value less than .001, which supports the split they used. So overall it looks like low vitamin D may be linked to heavier weight, more hypertension, and more metabolic issues.

Table 2: Association Between Vitamin D Deficiency and Clinical Outcomes:

Clinical Outcome	Vitamin D Deficient (n=58)	Sufficient Vitamin D (n=36)	Odds Ratio (95% CI)	p-value
Hypertension	35 (60.3%)	12 (33.3%)	3.05 (1.25–7.42)	0.012*
Metabolic Disorder	31 (53.4%)	9 (25.0%)	3.47 (1.33–9.04)	0.009*
Combined Outcome (HTN + Metabolic Disorder)	26 (44.8%)	7 (19.4%)	3.42 (1.23–9.53)	0.014*

Table 2 shows how not having enough vitamin D links to three health problems: high blood pressure, a metabolic issue, or both together. People whose blood test showed low 25-hydroxy-vitamin D were a lot more likely to be sick. The odds ratio for hypertension was about 3.05 (the confidence interval was 1.25-7.42, p = 0.012). For the metabolic problem the odds went up to 3.47 (CI = 1.33-9.04, p = 0.009). And when you look at the combo of the two, the odds were 3.42 (CI = 1.23-9.53, p = 0.014). So low-vitamin-D people are roughly three times more likely to get high blood pressure, metabolic trouble, or both, when you compare them to folks with enough vitamin D. This gives a clear number-based reason to think vitamin D levels could be changed to help stop heart-related and metabolism-related diseases.

DISCUSSION:

Our numbers match a lot of other studies that say vitamin D low-status is tied to bad heart and metabolism signs. Across many groups, low 25-hydroxy-vitamin D has been linked again and again to higher blood

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pressure, bad insulin response, weird cholesterol numbers and the whole metabolic-syndrome picture. In our group, the effect size (around an OR of 3) looks big enough to matter – maybe as big as eating too much salt or never moving. Vitamin D seems to calm down the renin-angiotensin system (the body's fluid-and-blood-pressure controller). When you have enough vitamin D, a piece called 1,25-dihydroxy-vitamin D tells kidney cells to make less renin, which then drops angiotensin II and keeps aldosterone from holding on to too much salt. If you're low on vitamin D that brake goes away, renin rises, fluid builds up and blood pressure climbs. Some lab work also shows that without vitamin D the walls of blood vessels get stiffer and the smooth muscle grows more – both can add to higher pressure. Vitamin D also talks to the pancreas and muscles. The pancreas has vitamin D receptors, so when vitamin D binds there it can help cells release insulin and keep them from dying when they're angry (inflamed). In muscle and fat tissue, vitamin D helps make more of the transporters that pull glucose inside cells, so the body uses sugar better. In our data, the low-vitamin-D crowd had higher fasting sugar, bigger HOMA-IR numbers (a sign of insulin resistance) and worse cholesterol – more triglycerides, less good HDL. That fits the idea that missing vitamin D throws off the whole sugar-and-fat balance. Being overweight can pull vitamin D into fat stores, making less of it reachable in the blood (the "sequestration" idea). At the same time, people with higher BMI often stay indoors, wear more clothes, and eat less vitamin-D-rich food, all of which drop their vitamin D levels (the "lifestyle" idea). One paper even describes a loop: more fat = less vitamin D, which then makes insulin resistance and bad lipids worse, which keeps the metabolic-syndrome rolling.

Not every study agrees. A few have found no link between low vitamin D and high blood pressure. Why? Maybe different genetics that change how the vitamin-D receptor works, different sunshine amounts in

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various places, or even different lab methods to measure vitamin D. Our own work is cross-sectional – we took a snapshot, not a movie over time – so we can't say for sure vitamin D low-status causes disease or the disease lowers vitamin D. Some researchers argue that inflammation or kidney trouble can drop vitamin D, making the "chicken-or-egg" question tough.

Vitamin D is something we can change. Some simple actions could help: adding vitamin D to milk or breakfast cereal, teaching people how to get safe sunlight, giving pills to those who need them (older adults, indoor workers, folks way up north). Some experts even suggest checking vitamin D levels when doctors assess heart-risk, so low levels can be fixed early. That might be a cheap way to cut down hypertension and the metabolic-syndrome burden.

To really sort this out we need long-term studies that follow people's vitamin D numbers and see if hypertension or metabolic problems appear later. Also, randomized trials where one group gets a set dose of vitamin D and another gets a placebo – and where they also look at different genes and starting vitamin D levels – would tell us if fixing the deficit really makes blood pressure and sugar numbers better. Those kinds of data would let guidelines say for sure whether we should push vitamin D supplements as part of broad disease-prevention plans.

CONCLUSION:

Low vitamin D is common everywhere, in all ages. Our analysis shows a clear link between not having enough vitamin D and both high blood pressure and metabolic trouble. That pushes the view of vitamin D beyond just keeping bones strong – it may be a key player in blood-pressure control and metabolic balance. Spotting low levels early, adding vitamin D through food or pills, and encouraging safe sun could be a practical route to cut the disease load from hypertension and the metabolic-syndrome. Still, we

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need big, long-watch studies and well-run trials to know if changing vitamin D really fixes these problems.

Until then, doctors should keep an eye on vitamin D status as a possible piece of the prevention puzzle.

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