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Association of Chronic Psoriasis with Syndrome X

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ABSTRACT

Psoriasis is a chronic skin disorder and has been associated with a number of chronic inflammatory conditions. Syndrome X, which is commonly seen in our population and is responsible for major cardiovascular events, has been found to be linked with chronic skin disorders. **Objective:** To find out the link between Syndrome X and chronic plaque psoriasis in our population, to estimate the disease burden and plan the management strategies accordingly. **Methods:** This study included 130 participants selected through consecutive sampling including 65 patients as diagnosed cases of chronic plaque psoriasis and rest of 65 were controls. Data collection involved measuring body size, blood pressure, and lab investigations with lipids panel, complete blood counts and fasting sugar levels. For the diagnosis of Syndrome X, National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria was applied. **Results**: The study results revealed that Syndrome X was common in the psoriasis patients (41.5%) than the other group (23.1%) with a p value of 0.035. The majority of psoriasis patients were obese, had hypertension, sugar levels were elevated, higher triglycerides, and low HDL cholesterol. The bivariate analysis indicated that psoriasis was associated with the high tendency of developing syndrome X (p value of 0.021). **Conclusion:** The study findings highlighted that appropriate treatment of syndrome X in patients with chronic psoriasis can reduce the cardiovascular complications.

INTRODUCTION

Psoriasis is a chronic inflammatory skin disorder, mediated by autoimmunity and is demonstrated by characteristic skin lesions having papules and silvery plaques along with skin inflammation [1]. It mainly affects body areas like scalp, elbows and knees. The Global burden of disease survey 2019 showed approximately 4,622,594 new cases of psoriasis globally in the year 2019, majority of those patients had age of 60 or above and most of the cases were from countries with good socioeconomic status [2]. Psoriasis has been found to be linked with Syndrome X that comprises of components including diabetes mellitus, lipid abnormalities, high blood pressure and obesity. Evidence suggests that chronic psoriasis is linked to syndrome X and Hidradenitis suppurativa that emphasizes the necessity to diagnose and manage these co morbidities. As psoriasis is interconnected with severe vascular events and syndrome X, therefore evaluation and screening for dyslipidemia and metabolic derangements should be done in these patients. The cardiovascular complications are more common in people with psoriasis hence timely diagnosis and management is essential to reduce the extra dermatological complications [3]. Apart from syndrome X, psoriasis has also been found to be associated with diabetes, fatty liver and chronic renal impairment [4]. Psoriasis is more commonly seen in people with abdominal obesity, elevated blood pressure, dyslipidemia, and

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abnormal glucose tolerance[4, 5]. Psoriasis has been found to be linked with the elevation of certain mediators and adipokines [6]. Psoriasis mediated inflammation is an important element for atherosclerosis, underscoring clinical implications of addressing these co morbidities among psoriasis patients [7]. There was an increased prevalence of Syndrome X among those people who had psoriatic arthritis that highlights the negative effects of psoriatic disease on metabolic health [8]. Moreover, psoriasis has been associated with Non-Alcoholic Liver Disease (NALD), and also Polycystic Ovarian Syndrome (PCOS) [9]. This association of several metabolic co morbidities that are correlated with psoriasis emphasizes the need for metabolic assessment and management of psoriasis patients. The available evidence shows that most of the studies that have been carried out showed a higher occurrence of Syndrome X among those people who were suffering from psoriasis as compared to the general population. However, there is a dearth of data from the developing world, particularly from the Pakistani population. Since the syndrome X has been associated with significant cardiovascular morbidity and mortality, understanding its prevalence and association with psoriasis is important so as to device screening and management strategies. In this research, we wanted to see the relationship between chronic plaque psoriasis and syndrome X.

The rationale of the study was to observe the relationship between chronic plaque Psoriasis and Syndrome X in this population and hence plan the management or preventive strategies accordingly, that would be helpful in reducing the morbidity and mortality associated with the extra dermatological manifestations of this disease.

METHODS

This was a case-control research study conducted in the Dermatology Department of Farooq teaching hospital (Akhter Saeed Medical College, Islamabad Campus Pakistan after taking the ethical approval from the institutional ethical review board with approval number - IRB0413.This study included 130 participants calculated using WHO calculator for estimating a population proportion taking Confidence interval 95%, 80% power of study and 5% level of significance with 65 patients diagnosed with chronic plaque psoriasis (cases) and 65 individuals without psoriasis (controls). (The prevalence of metabolic syndrome is estimated to be 10% in general population and 29% in psoriatic patients [10, 11]. After taking informed consent, the participants were recruited through consecutive sampling from outpatient dermatology clinics. Patients with chronic plaque psoriasis of age between 20-60 years, and disease duration of at least 6 months were included in the study. Controls were selected from individuals visiting the hospital for routine health check-ups or non-dermatological conditions, with no history of psoriasis or other chronic inflammatory diseases. Exclusion criteria for both groups included current use of systemic steroids, cyclosporine, systemic retinoid, immunosuppressant, pregnancy. Demographic data, including gender, age, and medical history, were gathered through medical records and structured interviews. For all participants, the following measurements were recorded: we had included anthropocentric measurements such as waist circumference. Body Mass Index (BMI) estimation was done using weight and height. Readings of blood pressure were taken for both systolic and diastolic pressure, recorded twice, with the average value noted after the participant had been sitting for at least 5 minutes. The biochemical tests involved taking 5 ml of blood from a vein after the person fasted for 12 hours overnight. Blood sugar levels were checked and the lipid profile including HDL cholesterol, total cholesterol, and triglycerides, was measured using enzyme-based tests. Syndrome X was diagnosed as per National Cholesterol Education Program's Adult Treatment Panel III (NCEP ATP III) criteria. A participant was considered to have Syndrome X if 3 of following were present including high blood pressure of 130/85 mm Hg or more or taking antihypertensive, abdominal obesity (waist size of at least 80 cm for women, at least 90 cm for men, high fasting blood sugar (at least 100 mg/dl) or using diabetes medication, high triglycerides of at least 150 mg/dl and above) or using lipid lowering medication, and low HDL cholesterol (50 mg/dl or lower for women and 40 mg/dl or lower for men). SPSS version 22.0 was employed for data analysis. Average values for continuous data have been described as mean ± standard deviation (SD), whereas the categorical data was shown as percentages and frequencies. The prevalence of metabolic syndrome among the cases and controls was examined using chi-square test for categorical data and t-test for continuous data. Bivariate analysis was used to see any link between chronic plaque psoriasis with metabolic syndrome and it component factors. A p-value of 0.05 or less was taken as statistically significant.

RESULTS

This study included 130 participants, comprising 65 psoriasis patients (cases) and 65 non-psoriatic individuals (controls).The mean age of cases and controls was 45.8 years and 44.9 years, respectively. Male participants constituted 64% of cases and 61% of controls. Comparison of metabolic parameters revealed that blood pressure, waist circumference, blood glucose, and triglyceride levels were higher in psoriasis patients compared to controls. In contrast, HDL cholesterol levels were lower in cases than in

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controls.

Table 1: Distribution of Characteristics

Variables	Cases Mean ± SD / Frequency (%)	Controls Mean ± SD / Frequency (%)	p-Value
Age (Years)	45.8 ± 11.6	44.9 ± 11.3	0.765
Gender			
Male	42 (64.6)	40 (61.5)	0.728
Female	23 (35.4)	25 (38.5)	
Waist Circumference (cm)	89.3 ± 12.4	84.7 ± 11.8	0.035
Blood Pressure (mmHg)			
Systolic	128.4 ± 16.7	122.1 ± 14.3	0.044
Diastolic	82.5 ± 10.2	78.6 ± 9.8	0.048
Fasting Glucose (mg/dl)	106.7 ± 20.1	98.4 ± 18.3	0.039
Serum Triglycerides (mg/dl)	168.9 ± 54.6	142.5 ± 49.8	0.033
HDL Cholesterol (mg/dl)	38.2 ± 11.4	45.6 ± 12.9	0.041
Duration of Psoriasis (Years)	10.2 ± 5.1	-	-

The study revealed high rate of metabolic syndrome was in the psoriasis patients as compared to the controls with 41.5% compared to 23.1% (p = 0.035). Table 1 provides details on the specific constituents of metabolic syndrome in both groups.

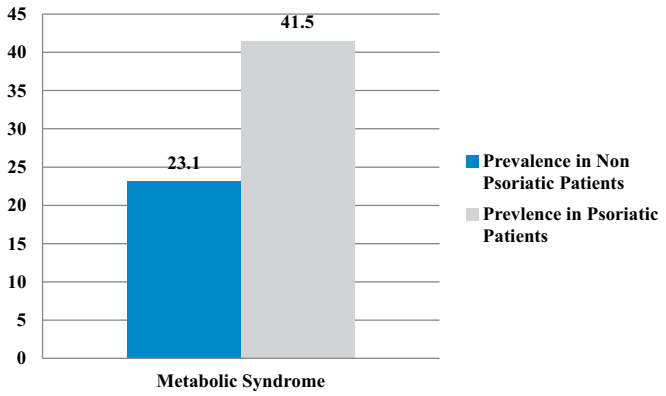

Figure 2: Prevalence of Metabolic Syndrome in Psoriatic Patients

The elements of metabolic syndrome were significantly high in patients with chronic psoriasis compared to controls. Abdominal obesity was observed in 46% (30/65) of cases and 29% (19/65) of controls (p = 0.042). Elevated blood pressure was present in 52% (34/65) of cases compared to 35% (23/65) of controls (p = 0.048). Elevated fasting blood glucose levels were found in 38% (25/65) of cases and 22% (14/65) of controls (p = 0.039). Elevated serum triglycerides were noted in 44% (29/65) of cases and 27% (18/65) of controls (p = 0.033). Reduced HDL cholesterol levels were seen in 49% (32/65) of cases compared to 31% (20/65) of controls (p = 0.041).

Table 2: Prevalence of Metabolic Syndrome Elements in Cases and Controls (n=130)

Component	Cases Frequency (%)	Controls Frequency (%)	p-Value
Abdominal Obesity	30 (46)	19 (29)	0.042
Elevated Blood Pressure	34 (52)	23 (35)	0.048
Elevated Fasting Glucose	25 (38)	14 (22)	0.039
Elevated Triglycerides	29 (44)	18 (27)	0.033
Reduced HDL Cholesterol	32 (49)	20 (31)	0.041

When the data were separated by gender, 43% of male psoriasis patients had metabolic syndrome as compared with 25% male controls (p of 0.038). Among women, 39% of those with psoriasis had metabolic syndrome in contrast to 20% of female controls (p value 0.041). An analysis by age revealed that 39% of psoriasis patients aged 50 or younger had metabolic syndrome, while it was 22% in controls of the same age (p = 0.032). For those over 50, the prevalence was 44% in psoriasis patients versus 24% in controls (p = 0.039). The average duration of psoriasis among the cases was 10.2 years. Metabolic syndrome was more in patients with psoriasis disease duration of at least 10 years compared to those with the disease of less than 10 years duration. (50% vs. 31%, p = 0.027).

Table 3: Bivariate Analysis of different Parameters

Variables	Prevalence of Metabolic Syndrome		p-Value
	Cases (%)	Controls (%)	
Male	43	25	0.034
Female	39	20	0.041
Ageless than 50	39	22	0.032
Age More than 50	44	24	0.039
Psoriasis More than 10 Years	50	Nil	0.027
Psoriasis Less than 10 Years	31	Nil	

The study also revealed that patients with chronic plaque psoriasis had a significantly increased rate of developing metabolic syndrome compared with people without psoriasis. The findings high lights importance of routine screening for metabolic syndrome components in patients with psoriasis to facilitate timely diagnosis and management, thereby reducing the risk of cardiovascular and other related complications. Figure 2 showed the percentage distribution of patients with metabolic syndrome in each sub-group, emphasizing the disparities in prevalence according to age, gender, and the duration of psoriasis.

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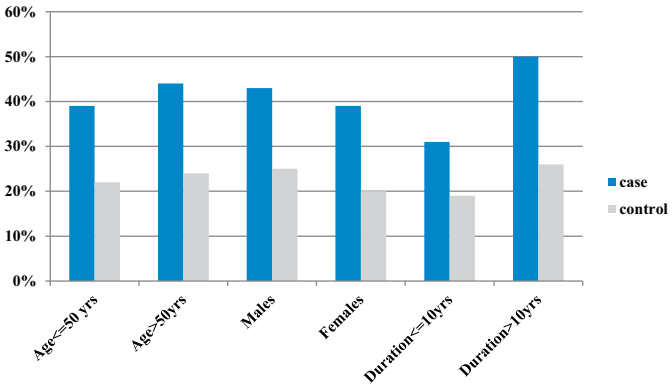

Figure 2: Prevalence of Metabolic Syndrome in different Groups

DISCUSSION

This case-control study found a strong connection between chronic plaque psoriasis and metabolic syndrome. The metabolic syndrome was much more common among psoriasis cases (41.5%) compared with control group (23.1%) supportive of the idea that psoriasis, as a chronic inflammatory condition, is linked to metabolic disorders. The study also showed that all aspects of metabolic syndrome were frequently observed in people with psoriasis compared with normal healthy individuals. These data are comparable to the results from few other studies showing the association between chronic systemic inflammation in psoriasis and metabolic syndrome [6, 7]. Significant gender and age differences in the frequency distribution of metabolic syndrome. People with psoriasis both male and female, showed a higher rate of metabolic syndrome than their control groups. Hormonal differences may affect fat distribution and metabolism, leading to this difference between genders [8, 9]. Literature also suggests that elevated cytokines like TNF-α and Interleukin-6 are crucial in psoriasis. However, published data also shows that this increased burden of inflammatory cytokines interfere with insulin signaling, and also promote fat accumulation therefore that results in dyslipidemia and hypertension [10, 11]. Older psoriasis patients over 50 had a higher rate of metabolic syndrome than younger ones. This suggests that metabolic risks increase with age [12]. It highlights the fact that close monitoring and timely management in older patients would be beneficial [13, 14]. Many studies have found that patients with psoriasis have more propensity to develop metabolic syndrome therefore evaluation of association between the two disorders is important [15, 16]. A study review also confirmed a strong link between psoriasis and metabolic syndrome [17]. This association could be because long-term inflammation affects both the skin and how the body manages metabolism [18]. Certain inflammatory proteins like TNF-α and IL-6 are out of balance in psoriasis. These proteins can cause insulin problems, weight gain, and bad cholesterol, which are key parts of metabolic syndrome [19]. Another study investigated the association of palmoplantar plaque psoriasis with diabetes, hypertension, obesity, and metabolic syndrome [20]. People who have psoriasis for at least 10 years have high chances to develop metabolic syndrome than those with disease of short duration. This showed that psoriasis is a chronic disorder involving the whole body, with ongoing inflammation increasing the risk of metabolic issues over time. A growing evidence suggests that metabolic syndrome and psoriasis are strongly linked, their prevalence is increasing especially more in patients with psoriatic arthritis [21, 22]. They also found higher rates of high triglycerides and belly fat in psoriasis patients. However, Depression and mood related disorders are also more common in patients with Psoriasis and metabolic syndrome with inflammation as a likely precipitating factor [23, 24]. Research by Al-Hamad and Raman found that 41.5% of psoriasis patients had metabolic syndrome, compared to 23.1% of people without the disease [25]. Although current literature sheds light on the connection between chronic plaque psoriasis and metabolic syndrome, there are still many questions that need answering. No understanding regarding the biological mechanisms that drive this association. Future research should aim to uncover the pathways through which chronic inflammation in psoriasis leads to metabolic issues. Moreover, conducting more studies in diverse populations is crucial to see if these findings hold true across different ethnic and regional groups. This could help us better understand any potential variations in how psoriasis and metabolic syndrome are linked. This study had few limitations. The case-control design cannot establish causality between psoriasis and metabolic syndrome. The sample size, although adequate to show significant associations, might not be suitable to the broader population. Future longitudinal studies with bigger samples can be done to see the temporal relationship and underlying mechanisms between these conditions. Secondly, the study was conducted in one particular location hence results may show variation in other areas of this country therefore further studies preferably multi centric using larger sample would be appropriate.

CONCLUSIONS

This study highlighted the significant link between chronic plaque psoriasis and metabolic syndrome, therefore regular screening of patients with psoriasis for syndrome X along with comprehensive management strategies are important. Early intervention and lifestyle modifications can potentially reduce the chances of cardiovascular complications in these patients as usually the extra dermatological complications are often overlooked. Further research is warranted to explore the

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pathophysiological links and develop targeted therapeutic approaches that address both psoriasis and its metabolic comorbidities.

Authors Contribution

Conceptualization: MFB, TMS
Methodology: ME, MN, JM
Formal analysis: ME, MN, JM
Writing, review and editing: MFB, ME, MN, TMS, JM, WSB
All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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REFERENCES

[1] Saleem S, Imran Z, Samdani A, Khoso B, Zehra S, Azhar A. Mutations in PGRN gene associated with the risk of psoriasis in Pakistan: a case control study. BioMed Central Medical Genomics.2023Dec;16(1): 335. doi: 10.1186/s12920-023-01757-8.

[2] Damiani G, Bragazzi NL, Karimkhani Aksut C, Wu D, Alicandro G, McGonagle D *et al.* The global, regional, and national burden of psoriasis: results and insights from the global burden of disease 2019 study. Frontiers in Medicine.2021Dec;8:743180.doi:10.3389/fmed.2021.743180.

[3] Michalska A, Teichman R, Kręcisz B, Siudak Z, Stępień R, Sadowski M. Cardiovascular risk in patients with plaque psoriasis and psoriatic arthritis without a clinically overt cardiovascular disease: the role of endothelial progenitor cells. Advances in Dermatology and Allergology/Postępy Dermatologii i Alergologii.2020Jun;37(3):299-305.doi:10.5114/ada.2020.96085.

[4] Fernández-Armenteros JM, Gómez-Arbonés X, Buti-Soler M, Betriu-Bars A, Sanmartin-Novell V, Ortega-Bravo M *et al.* Psoriasis, metabolic syndrome and cardiovascular risk factors. A population-based study. Journal of the European Academy of Dermatology and Venereology.2019Jan;33(1):128-35. doi: 10.1111/jdv.15159.

[5] Gisondi P, Galvan A, Idolazzi L, Girolomoni G. Management of moderate to severe psoriasis in patients with metabolic comorbidities. Frontiers in Medicine.2015Jan;2:1.doi:10.3389/fmed.2015.00001.

[6] Jiang Y, Chen Y, Yu Q, Shi Y. Biologic and small-molecule therapies for moderate-to-severe psoriasis: focus on psoriasis comorbidities. BioDrugs.2023 Jan; 37(1): 35. doi: 10.1007/s40259-022-00569-z.

[7] Kiełbowski K, Bakinowska E, Bratborska AW, Pawlik A. The role of adipokines in the pathogenesis of psoriasis-a focus on resistin, omentin-1 and vaspin. Expert Opinion on Therapeutic Targets.2024Jul; 28(7): 587-600. doi: 10.1080/14728222.2024.2375373.

[8] Ramos LM, Gomes KW, de Saboia Mont'Alverne AR, Braga MV, Vasconcelos AH, Rodrigues CE. High prevalence of metabolic syndrome in patients with psoriatic arthritis from Northeastern Brazil: association with traditional cardiovascular risk factors and biologic disease-modifying antirheumatic drugs. JCR: Journal of Clinical Rheumatology.2021Sep;27(6S):S186-92.doi:10.1097/RHU.0000000000001631.

[9] Lee TH, Wu CH, Chen ML, Yip HT, Lee CI, Lee MS *et al.* Risk of psoriasis in patients with polycystic ovary syndrome: a national population-based cohort study. Journal of Clinical Medicine. 2020 Jun; 9(6): 1947. doi: 10.3390/jcm9061947.

[10] Malik T, Nasreen S, Memon HS, Yousuf S, Khan S, Gul S. Association of Metabolic Syndrome and Psoriasis. Population.2022Jun;6(4):1104-1106.doi:10.53350/pjmhs221641104.

[11] Liu L, Cai XC, Sun XY, Zhou YQ, Jin MZ, Wang J *et al.* Global prevalence of metabolic syndrome in patients with psoriasis in the past two decades: current evidence. Journal of the European Academy of Dermatology and Venereology.2022 Nov; 36(11): 1969-79. doi: 10.1111/jdv.18296.

[12] Fabrazzo M, Romano F, Arrigo M, Puca RV, Fuschillo A, De Santis V *et al.* A multivariate analysis of depression prevalence in psoriasis patients: a cohort study. International Journal of Environmental Research and Public Health.2022Feb;19(4):2060.doi:10.3390/ijerph19042060.

[13] Tariq J, Humaira M, Ahmed A, Memon A, Memon N, Shah M. Metabolic Syndrome in Obese and Non-Obese Individuals Presented at A Tertiary Care Hospital of Hyderabad, Pakistan: Metabolic Syndrome in Obese and Non-Obese Individuals. Pakistan Journal of Health Sciences. 2024 Nov: 226-30. doi: 10.54393/pjhs.v5i11.2549.

[14] Arif A, Siddiqui S, Shafiq S, Rashid S, Aman S. Frequency of metabolic syndrome in patients of chronic plaque psoriasis. 2023 Jul.

[15] Azhar M, Younas MT, Tahir M, Masud M, Tahir MZ, Tahir MZ. Prevalence of Metabolic Syndrome in patients with psoriasis. BioMed Central Journal of Medical Sciences.2023 Dec; 4(2): 11-5. doi: 10.70905/bmcj.04.02.0149.

[16] Sabir, S., Ilyas, S., Khan, M., Imtiaz, H., & Khan, E. (2022). Frequency of Metabolic Syndrome in Patients with Chronic Plaque Psoriasis. Pakistan Journal of Medical & Health Sciences.2022; 16(12): 256-256. doi: 10.53350/pjmhs20221612256.

[17] Ghias A, Khan MS, Shaheen E. Frequency of metabolic syndrome in patients of psoriasis. 2018 Jul.

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DOI: https://doi.org/10.54393/pjhs.v6i7.1826

[18] Raza MH, Iftikhar N, Mashhood AA, Hamid MA, Rehman F, Tariq S. Frequency of metabolic syndrome in patients with psoriasis. Journal of Ayub Medical College Abbottabad. 2021 Jun; 33(3): 484-7.
[19] Wang X, Wang L, Wen X, Zhang L, Jiang X, He G. Interleukin-18 and IL-18BP in inflammatory dermatological diseases.Frontiers in immunology. 2023Jan;14:955369.doi:10.3389/fimmu.2023.955369.
[20] Rathod A, Neema S, Radhakrishnan S, Vendhan S, Tripathy DM, Vasudevan B. Palmoplantar Plaque Psoriasis is Associated with Diabetes, Hypertension, Obesity, and Metabolic Syndrome-A Case-Control Study. Indian Dermatology Online Journal.2022 Sep; 13(5): 606-10. doi: 10.4103/idoj.idoj_59_22.
[21] Palmer V, Cornier MA, Waring A, Valdebran M. Evaluation and treatment of metabolic syndrome and cardiovascular disease in adult patients with psoriasis. International Journal of Dermatology. 2023 Dec; 62(12): 1437-46. doi: 10.1111/ijd.16873.
[22] Rodríguez-Zúñiga MJ and García-Perdomo HA. Systematic review and meta-analysis of the association between psoriasis and metabolic syndrome. Journal of the American Academy of Dermatology.2017Oct;77(4):657-66.doi:10.1016/j.jaad.2017.04.1133.
[23] Hao Y, Zhu YJ, Zou S, Zhou P, Hu YW, Zhao QX *et al.* Metabolic syndrome and psoriasis: mechanisms and future directions. Frontiers in Immunology. 2021 Jul; 12: 711060. doi: 10.3389/fimmu.2021.711060.
[24] Fahed G, Aoun L, Bou Zerdan M, Allam S, Bou Zerdan M, Bouferraa Y *et al.* Metabolic syndrome: updates on pathophysiology and management in 2021. International Journal of Molecular Sciences.2022 Jan; 23(2): 786. doi: 10.3390/ijms23020786.
[25] Al-Hamad D and Raman V. Metabolic syndrome in children and adolescents. Translational Pediatrics. 2017 Oct; 6(4): 397. doi: 10.21037/tp.2017.10.02.

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