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Medicine

PREVALENCE OF DIABETIC RISK FACTORS IN MEDICAL STUDENTS

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ABSTRACT

Background: India prosperity associated with rise in altered lifestyle and dietary habits, so also the metabolic diseases. This prompted us to search risk factors in medical students.

Material and Method: 450 medical students were studied.

Results: 421 students (182 male and 239 female) had completed the study. Mean age of male (M) and female (F) students was 19 ± 1.128. Diabetes mellitus (DM) was comparatively common in relatives of female students. 32.78% students had obese relatives, especially paternal diabetic, and both parental and maternal diabetic relatives, Hypertension (HTN) [M=13.74% & F= 18.41%] and coronary artery disease (CAD). Underweight students were 48 [M= 19 & F= 29] and overweight 191 [M= 91 & F= 100]. 31.61% male students had waist ≥ 90 cm and 32.42% female ≥ 80 cm, and Waist – Hip Ratio (WHR) ≥0.90 in 38.06% male and ≥ 0.80 in 36.53% female. Low birthweight students were 26 (M= 7 & F= 19) and high birthweight 9 (M=5 & F=4). Systolic HTN was present in 31 (M=26 & F=5) and diastolic HTN in 32 (M=18 & F=14). One male was diabetic and 3 female had Glucose Intolerance and 4 had PCOD.

Conclusion: Students, particularly female and "normal-weight metabolically obese", were at risk of developing DM, obesity, HTN and CAD. Parental DM determined high birth weight. Most of female students were underweight, suggesting DM in lean subjects may shift from male to female. "Obesity paradox" present in students because of "metabolically unhealthy normal-weight".

KEYWORDS : Obesity, physical inactivity, "obesity paradox"

INTRODUCTION:

India is prospering, so associated increase burden of altered dietary and sedentary lifestyle affecting population with metabolic diseases. These appear now in young age. Other contributory factors to these diseases are: genetic propensity, "normal-weight lean mass", physical inactivity, dietary habits, poor nutrition in pregnancy, childhood obesity, westernized lifestyle etc. In medical students, problem is further compounded by stressful academic life. This study is to find out the risk factors for DM and other metabolic morbidities. We planned appropriate suggestions for the vulnerable students.

MATERIAL & METHOD:

This study was conducted in a territory Medical College. 450 medical students were enrolled.

Duration of Study: About One Year
Inclusion criteria: All students. **Exclusion criteria**: nil.

Study design:

Students were informed about the study. Those who consented were included and evaluated clinically. History of: symptoms of metabolic diseases, drug therapy (influencing metabolism), F/H/O chronic metabolic diseases. Clinical examination included Weight measurement (Kg), Height (cm), BMI, Waist (W) and Hip (H) circumference, W/H ratio. BMI for overweight was considered as 23Kg/m² (**1**), abdominal adiposity if waist circumference as > 90 cm in male and > 80 cm in female (**2**). Relevant biochemical tests were done. Bone mineral density (BMD) was calculated as an average of two readings each recorded for one minute, and classified (***3***): Normal: BMD score > -1, Osteopenia: BMD score < -1 and up to -2.5, Osteoporosis: BMD score < -2.5.

Ethical Issue: Institution Ethical Committee approved the study and conducted accordingly.

RESULTS:

421 students (M=182 & F=239) completed the study. Mean age of either sex was 19 ± 1.128 years.

Family history (Table – 1): 191 (45.37%) students, especially female, had diabetic relatives [Female 122 (50.21%)] & Male 69 (37.91%)]. F/H/O obesity was present in 35.71% & 30.54%, HTN 13.74% & 18.41%, CAD 2.2% & 0.84% respectively in relatives of male and female students, and dyslipidemia (parental relative of 1 female).

Table – 1(Depiction of Disabilities in Family)

Family History Diseases	Paternal M	Paternal F	Maternal M	Maternal F	Paternal & Maternal M	Paternal & Maternal F	Total
Diabetes mellitus	27	58	17	29	25	35	191 (45.37%) M= 69 (37.91%) F= 122 (50.21%)
Obesity	31	25	13	24	21	24	138 (32.78%) M= 65 (35.71%) F= 73 (30.54%)
Hypertension	19	35	1	5	5	4	69 (16.39%) M= 25 (13.74%) F= 44 (18.41%)
CAD	4	1	-	1	-	-	6 (1.43%) M= 4 (2.2%) F= 2 (0.84%)
Dyslipidemia	-	1	-	-	-	-	F= 1 (0.42%)

(N.B. M=male students, F = female students, CAD= coronary artery disease; Paternal family history = Father and paternal relatives of students; Maternal Family history = Mother and maternal relatives of students.)

Association of DM (Paternal) with obesity (Table–2): 85 students had parental DM relatives. Obesity was present more in paternal DM relatives.

Table – 2 (Association of Diabetes mellitus with Obesity, HTN and CAD in family)

Family history of DM and other co morbidities	Obesity in Paternal relatives M	Obesity in Paternal relatives F	Obesity in Maternal relatives M	Obesity in Maternal relatives F	Obesity in Paternal & Maternal relatives M	Obesity in Paternal & Maternal relatives F
Diabetes mellitus						
DM (Pat) N=85 (M=27, F=58)	7	15	4	5	6	7
DM (Mat) N=46 (M= 17, F=29)	3	5	1	5	6	5
DM (Pat & Matl N=60 (M= 25, F=35)	4	6	3	6	5	3

DM, Obesity & HTN	HTN in Paternal relatives		HTN in Maternal relatives		HTN in Paternal & Maternal relatives	
	M	F	M	F	M	F
DM (Pat) with Obesity & HTN						
Obesity (Pat)= 22	**1**	**5**	0	0	0	0
Obesity (Mat)= 9	**1**	**1**	0	0	0	0
Obesity (Pat & Mat)= 13	**1**	**1**	0	0	**1**	0
DM (Mat) with Obesity & HTN						
Obesity (Pat)= 8	**1**	**1**	0	**1**	0	0
Obesity (Mat)= 6	0	0	0	**1**	0	0
Obesity (Pat & Mat)= 11	**3**	**1**	0	0	**1**	**1**
DM (Pat & Mat) with Obesity & HTN						
Obesity (Pat)= 10	**2**	**2**	0	0	0	0
Obesity (Mat)= 9	**1**	**1**	0	0	0	**2**
Obesity (Pat & Mat)= 8	0	0	0	0	**3**	**3**
CAD Associated with	**Pat relatives**		**Mat relatives**		**Pat & Mat relatives**	
	M	F	M	F	M	F
DM, Obesity & HTN	**2**	**1**	0	0	0	0
DM & HTN	**1**	0	0	0	0	0
DM & Obesity	**2**	**1**	0	0	0	0
DM	0	0	0	**1**	0	0
Dyslipidemia Associated with	**Pat relatives**		**Mat relatives**		**Pat & Mat relatives**	
	M	F	M	F	M	F
DM, Obesity & HTN	0	0	0	**2**	0	0
DM, HTN & CAD	0	0	**1**	0	0	0
Obesity & HTN	0	0	**1**	0	0	0

(**N.B.** Analysed data depicts number of students (male and female) having F/H/O. Pat = Paternal family & close relatives and Mat = Maternal family & close relatives)

Association of DM (Maternal) with obesity (Table – 2): 46 students had maternal DM. Obesity was present in paternal, and parental and maternal relatives.

Association of DM (both Paternal & Maternal) with obesity (Table – 2): Students 60 [F=35 (14.64) & M=25 (13.74%)] had DM in both relatives and almost all were obese.

Association of DM, Obesity and HTN (Table – 2): Out of 85 Paternal DM families HTN was present in relatives of 11 (M= 4 & F=7) students, especially in diabetic parental & maternal relatives with or without obesity. Prevalence was more in *parental* obese relatives i.e. parental (N=35) & maternal (N=22) respectively.

Association of CAD with DM, Obesity and HTN (Table – 2): 8 students had F/H/O CAD, all relatives were diabetic, and 6 obese and 4 hypertensive. All morbidities were reported in 1.

Association of Dyslipidemia with CAD, DM, Obesity and HTN (Table – 2): Dyslipidemia was present in maternal relatives of 4 students. Relatives of 2 female and 2 male students had multiple metabolic morbidities. Father of 3 students (F=2 & M=1) had premature death.

Anthropometry and Relevant parameters of Students:

(a) **Body Mass Index** (Table-3): Underweight 48 (11.4%) [M= 19 & F= 29], normal weight 182 (43.23%) [M= 72 & F= 110], and overweight students were 191 (45.37%) [M= 91 & F = 100].

Table – 3 (BMI of Students Sex-wise)

BMI (Kg/m²)	**SEX**		**Total**
	Male	**Female**	
≤ 18.5 (under-weight)	19 (10.44%)	29 (12.13%)	48 (11.4%)
18.5 – 22.9 (Normal weight)	72 (39.56%)	110 (46.03%)	182 (43.23%)
23 – 24.9 (Over weight)	35 (19.23%)	38 (15.9%)	73 (17.34%)
25 – 29.9 (Pre obese)	39 (21.43%)	41 (17.15%)	80 (19%)
30 & above	17 (9.34%)	21 (8.79%)	38 (9.03%)

(b) **Waist measurement** (WC): Students (M=27 & F=20) declined waist/ hip measurement. In 155 male: normal WC was present in 106 and ≥ 90 cm in 49, and in 219 female: normal WC in 148 and ≥ 80 cm in 71.

(c) **Waist – Hip Ratio**: WHR in 155 male students: normal (up to 0.90) in 96 and ≥ 0.90 in 59, and 219 female: normal (up to 0.85) in 139 (58.16%) and ≥ 0.85 in 80.

(d) **Birth Weight**: 279 students (M= 132 & F= 147) were unaware of birth weight. Low birth weight (<2.5 Kg) students were 26 (M= 7 & F= 19), normal birth weight 107 (M=38 & F=69) and high birth weight (> 4 kg) 9 (M=5 & F=4).Presently, of the 9 high birth weight students, 3 (M=2 & F=1) are obese, 5 with normal weight (M=3 & F=2) and 1 low weight (F=1).

Five (71.43%) low birth weight *male* students had F/H/O DM (2 paternal, 1 maternal, and 2 parental & maternal) and obesity in 3 (1 maternal, and 2 paternal & maternal). Presently, 2 students are underweight, 2 normal and 1 overweight. Similarly, low birth weight 10 *female* students had F/H/O DM (5 paternal, 2 maternal, and 3 parental & maternal) and obesity (3 paternal, and 3 parental & maternal). Presently, 2 students are underweight, 5 normal and 3 overweight.

(d) **Disabilities**: *Hypertension*: Systolic HTN was detected in 31 (M=26 & F=5) and diastolic HTN in 32 (M=18 & F= 14) student.

Diabetes mellitus: One male student was T1DM. 3 females had Glucose Intolerance.

Other disabilities: PCOD in 4 students.

(e) **Physical activities**: This Institution is located in hill. Most of the students walk over 750 feet distance to and from college. Walking is main exercise by most of them. Some students use other mode of exercise. Mild exercise was performed by 388 students (M=161 & F=236), moderate exercise by 22 (M=12 & F=10), and severe exercise by 11 (M=9 & F=2).

(f) **Bone Mass density**: Students (M=20 & F=15) declined BMD measurement. Mean BMD in remaining students (M=162 & F=224) was -0.129 ± 0.843 and 0.645 ± 0.842 respectively. 336 (87.05%) students [M=143 (88.27%) & F=193 (86.16%)] had normal BMD, Osteopenia in 50 [M=19 (11.73%) & F= 31 (13.84%)] and Osteoporosis in none.

DISCUSSION:

Dynamics of DM epidemic are changing rapidly (**4**). Once a disease of affluent, now DM is increasingly reported in low socio-economical class, obese children and in "lean mass obese" people. India prosperity parallels with increase in sedentary lifestyle and altered food habits which are risk to metabolic diseases, especially the DM. China has surpassed India in prevalence of DM (**5, 6**) because of fast economy growth. Many risk factors are attributed to the development of DM: genetic propensity, childhood obesity, sedentary lifestyle, poor

nutrition *in utero* and altered food habits. Now DM is diagnosed in young even with lower BMI (**6, 7**) or with normal BMI "normal-weight metabolically obese"'. Indians develop DM faster with gain in weight than western counterparts. Children born to Indian women with gestational diabetes (GDM) are more prone to T2 DM.

Almost all metabolic diseases have genetic influence and transmitted with variable penetration and expression due to interplay of genetic and environmental factors. As polygenetic transmission and influence of environmental factors are variable, it is difficult to find the individual's risk of developing disease.

We accepted family history and important clinical & biochemical parameters tool to assign student to a low, medium, or high risk group, because students in each risk group share certain characteristics that correlate with probability of developing a disease.

DM has clustering in the families due to strong genetic components, 65 genetic loci has been deciphered (**8 - 9**). 45.37% students [M=69 & F= 122] had F/H/O DM [In other studies: 72.9% (Qatar), 53.9% (South India) & 70% (Pakistan)] (**8, 33-34**)]. A child's risk of DM is about 50% when both parents are T2DM (**8**). Our, 60 (14.25%) students [M=25 & F=35] had F/H/O parental and maternal diabetics. Presently, these students are non-diabetic, we can assume that about 30 students (M 12 & F=17) may develop DM later on. Female with paternal or maternal diabetics are more prone to DM and this risk independent of a genetic score, but in men no such association exist (**9**). It means most of the 122 female students are at risk of developing DM at later age (**10**), but not all the male. Some studies found DM is substantially more related to F/H/O DM in mothers than in fathers (**35 - 36**), but in our study, students had predominant parental DM.

WC and WHR (indicators of central obesity) are associated with insulin resistance (IR) – a risk for DM. WC showed a stronger independent association with DM in all areas (**11**). 49 male and 71 female had increased WC, whereas increased WHR was present in 59 (38.06%) male and 80 female (36.53%) students. Since female are prone to DM development (**8-9**), increase WC & WHR further contribute to the development of IR / DM subsequently. Male students with abdominal adiposity are also vulnerable to "normal weight metabolic obese" related diseases.

48 under-weight students [M= 19 & F= 29] all were non diabetic, except one. Though, difficult to predict the future development of DM in them, yet we speculate by extrapolating results of our lean students (11.4%), with female predominance lean OPD population with 3.5% - 10% T2DM (BMI ≤ 18.5 kg/m^2) (**12-13**). Major difference is that we have evaluated non-diabetic underweight students and above studies evaluated T2DM underweight patients. Secondly, our students are affluent, whereas above studies screened lean diabetics from general population irrespective of financial status. Many studies have also found the significant prevalence of underweight DM in poor socio-economic class (**12, 14**). It is well documented that under birthweight children, exposed to plenty of food, have propensity to develop IR / DM. It is difficult to predict how many low weight students will develop DM.

Obese medical students were 9.03% [M=17 (9.34%) & F= 21 (8.79%)], our results differing from a study (conducted on affluent students) where incident of obesity was 3.4% (**15**). Pre-obese medical students were 19% [M= 39 & F= 41]. Overweight and Obesity are risk factors for DM – it is difficult to predict conversion of obese and pre-obese into IR, because of variation in gene penetration and phenotypic expression controlled by exogenous factors.

279 students were unaware of birthweight. In rest of the students low birth weight was in 26 and high birth weight 9. Low and high birthweights are known risks for T2DM (**16-19**). Some studies have demonstrated a 'U-shaped curve' relationship between them (**18-19, 32**), and other observed that low birth weight increased risk for T2DM and the high birthweight (**20**), and other found negative linear association (**21**). Exact mechanism unknown - how low birthweight increase T2DM risk. Various mechanisms are suggested: (i) compensatory adaptation to an adverse intrauterine environment, where development of important organs leads to IR and abnormal islet development (**22**), (ii) lack of important nutrients influencing fetal growth / metabolism (**23-24**), (iii) decrease oxidation ability of postprandial glucose and glycolysis in low birthweight (**25-26**), (iv) '*Fetal programming hypothesis*': lack of intrauterine nutrients causes a permanent metabolic shift towards IR to support brain glucose supply. After birth, the nutrient supply increases – resulting in obesity and IR (**27-28**), (v) '*Fetal Insulin Hypothesis*': genetic variants decrease insulin secretion and cause low birthweight (**29**) and (vi) leptin administration to rats during late pregnancy and lactation makes offspring less susceptible to high-fat-diet-induced weight gain and IR (**30**). Therefore, low birthweight may be a clinical marker of poor intrauterine environment and a risk for T2DM. It is seen that mostly male are lean diabetics with history of childhood malnutrition, poor socioeconomic status and onset of early DM, and increased risk of, cardiovascular and non-cardiovascular mortality when compared to obese diabetic patients (**31**). Secondly, as most of underweight students were female, the trend may shift lean diabetes from male to female predominance. Thirdly, though our low birthweight students have accessibility to food, only 3 female were overweight, 7 (M=3 and F=4) remained underweight and rest normal weight. Could it be a leptin effect, which offers resistance to T2 DM development (**30**). A high birth weight increases the risk of T2DM in male, whereas obesity in both sexes (**36**). Contrary to observation that high weight baby is born to diabetic mother, most of high birth weight female students had parental DM.

In normal weight category M=67 (36.81%) & F= 104 (57.14%) perform mild exercises daily. Is it conceivable that these normal weight students, performing mild exertion, with lean body mass metabolically healthy? High mortality has been documented in certain normal weight DM patients as compare to their obese counterparts. They are "metabolically unhealthy normal-weight". This phenomenon is called the "obesity paradox" (**31, 37**). It is akin to sarcopenic obesity (high body fat, with reduced lean mass). Most of our students being sedentary may have reduced lean mass and cardiopulmonary fitness, which makes them prone for premature death and higher mortality (**31, 37 - 38**). In these so called normal weight obese students F/H/O metabolic diseases was widely prevalent. Interestingly, F/H/O DM and HTN were more prevalent in parental relatives, whereas obesity in maternal relatives. These "metabolically unhealthy normal-weight" students, particularly female, are prone to metabolic syndrome related complications as compare to obese counterpart, (**39**).

Other risk factors for DM in students were:

- HTN and prehypertension were mostly prevalent in male students. HTN and IR are intricately related. Thus hypertensive students are prone to IR.
- Glucose intolerance in 3 female and PCOD in 4 female students.

Recommended preventive measures:

(i) Dietary factors:

- Avoid canned and junk food, soft beverages, alcohol and refined carbohydrates.
- Daily fresh fruits and vegetables: for men: 2 cups of fruit and 2½ to 3 cups of vegetables and for women: 1½ to 2 cups of fruit and 2 to 2½ cups of vegetables.
- Daily intake of 30 g nuts (20 almonds / 15 cashew nuts).
- Add animal products for proteins. For vegetarians soya bean and lentils can compensate.

(ii) Maintain body weight by healthy dietary habits, and appropriate exercises.

(iii) Physical activities: 30 min daily moderate intensity exercise, at least 5 days a week, or walking for 10,000 steps / day with fast pace. Climbing gradients, gardening, dancing, jogging etc. are other alternatives.

(iv) To avoid stress: Sound sleep for at least 6-8 hours, Yoga and meditation.

CONCLUSION:

Our participants lead sedentary lifestyle. Identifiable risk factors in these students, particularly in female, were DM, obesity, HTN, CAD and "normal-weight metabolically obese". Parental DM is important for high birthweight than maternal DM. Female students were mostly underweight. Future lean diabetes may tilt from 'male to female'. "Obesity paradox" exists in our study, this subgroup is equally vulnerable to metabolic diseases and called "metabolically unhealthy normal-weight".

Limitations of the study:

(i) family history and birthweight were only statement based. (ii) some biochemical parameters like lipid profile, glucose tolerance test and

leptin were not performed. (iii) visceral fat evaluation not done.

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Conflict of Interest: Nothing to disclose.
Authors' contribution: study design, collection and collating relevant medical literature, preparation of manuscript and editing and final revision.

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