



高原藏族人群血常规指标与代谢综合征的关联研究*

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【摘要】目的 探讨西藏藏族人群血常规指标与代谢综合征(metabolic syndrome, MetS)患病率及其风险因素的关联性。**方法** 2021年8月-2023年8月,通过多阶段分层整群随机抽样法,对西藏拉萨、阿里、那曲地区藏族人群进行问卷调查、人体测量、实验室检查,研究共纳入2832人。经调整潜在的混杂因素,采用logistic回归分析血常规指标与MetS的相关性。**结果** MetS患病率为11.5%,男性患病率为12.9%,女性患病率为10.6%。经混杂调整后结果显示,白细胞(WBC)、血红蛋白(Hb)、红细胞压积(HCT)、血小板体积分布宽度(PDW)与MetS患病有关。与最低的三分位数组Q1相比,WBC的Q2、Q3组的比值比(OR)OR值分别为1.629[95%置信区间(95%CI): 1.164~2.279, $P=0.004$]和1.621(95%CI: 1.14~2.292, $P=0.006$); Hb的Q2、Q3组的OR值分别为0.523(95%CI: 0.325~0.843, $P=0.008$)和0.435(95%CI: 0.212~0.889, $P=0.022$); HCT的Q2、Q3组的OR值分别为1.818(95%CI: 1.123~2.943, $P=0.015$)和2.480(95%CI: 1.208~5.089, $P=0.013$); PDW的Q2、Q3组的OR值分别为0.562(95%CI: 0.358~0.881, $P=0.012$)和0.614(95%CI: 0.381~0.991, $P=0.046$)。**结论** 西藏藏族MetS患病率低于国内水平,WBC、Hb、HCT、PDW平均水平与MetS患病有关,其中WBC和HCT为MetS患病的危险因素;Hb和PDW为保护因素,建议将血常规作为一种简单、有效的指标纳入代谢性疾病管理和控制。

【关键词】 高原 藏族人群 全血细胞计数 代谢综合征

Association Between Blood Routine Index and Metabolic Syndrome in High-altitude Tibetan Population

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[Abstract] Objective To investigate the relationship between blood routine indicators and the prevalence of metabolic syndrome (MetS) and its risk factors in the Tibetan population in Xizang. **Methods** From August 2021 to August 2023, a multi-stage stratified cluster random sampling method was used to conduct a questionnaire survey, anthropometric measurements, and laboratory examinations of the Tibetan population in the Lhasa, Ali, and Naqu areas of Xizang. A total of 2 832 people were included in the study. After adjusting for potential confounding factors, logistic regression analysis was used to examine the correlation between blood routine indicators and MetS. **Results** The prevalence of MetS was 11.5%, with rates of 12.9% among males and 10.6% among females. After adjusting for confounding factors, white blood cell count (WBC), hemoglobin (Hb), hematocrit (HCT), and platelet distribution width (PDW) were associated with MetS prevalence. Compared with the lowest tertile (Q1), the odds ratios (ORs) for Q2 and Q3 of WBC were 1.629 (95% CI: 1.164-2.279, $P=0.004$) and 1.621 (95% CI: 1.14-2.292, $P=0.006$), respectively. For Hb, the ORs in Q2 and Q3 were 0.523 (95% CI: 0.325-0.843, $P=0.008$) and 0.435 (95% CI: 0.212-0.889, $P=0.022$), respectively. The ORs for HCT in Q2 and Q3 were 1.818 (95% CI: 1.123-2.943, $P=0.015$) and 2.480 (95% CI: 1.208-5.089, $P=0.013$), respectively. The ORs for PDW in Q2 and Q3 were 0.562 (95% CI: 0.358-0.881, $P=0.012$) and 0.614 (95% CI: 0.381-0.991, $P=0.046$), respectively. **Conclusion** WBC, Hb, HCT, and PDW in the complete blood count were associated with the prevalence of MetS, WBC and HCT were risk factors for the prevalence of MetS, while Hb and PDW were protective factors. It is recommended that complete blood counts be included in the monitoring and management of

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metabolic diseases.

[Key words] Plateau Tibetan population Complete blood count Metabolic syndrome

代谢综合征(metabolic syndrome, MetS)是肥胖、高血糖/胰岛素抵抗等多种疾病的聚类,每一种成分都与动脉粥样硬化性心血管疾病和2型糖尿病的高风险密切相关^[1]。除遗传因素外,高热量、低纤维快餐式的饮食模式以及久坐不动的生活方式是MetS基本因素^[2]。据估计全球四分之一的人口患MetS^[3]。根据不同定义,2012–2015年中国的患病率从21.5%到32.3%不等^[4]。MetS的潜在机制尚不明确,但氧化应激、慢性炎症和胰岛素抵抗似乎是最可能的机制^[5]。由血流动力学改变引起的组织或细胞损伤有助于疾病进展,血常规反映心血管疾病和其他代谢疾病的发病机制提供多种信息^[6]。既往研究强调MetS成分与血液学参数的关联,包括白细胞、红细胞等计数水平作为血栓形成和炎症状态的潜在指标^[7]。同时作为价格低廉且可获性高的实验室检测指标,可通过血常规风险预估有可能以微小的增量成本提供重要的增量预测能力^[8]。

在平均海拔4500 m的青藏高原地区生活是一项生理挑战,高原低氧低气压的特殊环境可能导致当地人群的生理适应和功能变异,故本研究通过探讨西藏地区藏族人群血常规指数与MetS及其组分的相关性和变化,试图提供经济、快捷的MetS辅助诊断依据。

1 资料与方法

1.1 研究设计

2021年8月–2023年8月,根据多阶段分层整群随机抽样法,在西藏拉萨、阿里、那曲三市,按照人口比例抽取2~4个区/县;从样本区/县抽取2~3个社区/村庄的藏族居民作为调查对象,最终共纳入2832人。纳入标准:年龄≥18周岁;数据收集前连续6个月未离开当地。排除标准:严重疾病及精神疾病;数据不全者;孕产妇。研究在西藏大学伦理委员会批准下进行,参与者自愿签署知情同意书。

1.2 研究方法

1.2.1 问卷调查

由社会人口学特征(性别、年龄、职业等)与生活方式(吸烟、饮酒、体育锻炼等)构成。经过统一培训的精通藏汉双语且具有医学背景的调查员进行面对面访谈。

1.2.2 一般测量

按照标准使用校准后的仪器测量,包括身高、体质量、腰围、心率、血压等。

1.2.3 实验室检查

空腹12 h后经无菌操作采样后送检,检测机构具有

国家检测资质且符合标准。血生化检测:抽取外周静脉血5 mL,静置2 h后分离血清,使用全自动生化分析仪(日立7600型)测量总胆固醇(TC)、甘油三酯(TG)、高密度脂蛋白胆固醇(HDL-C)、低密度脂蛋白胆固醇(LDL-C)、谷丙转氨酶(ALT)、谷草转氨酶(AST)、血尿素、血清肌酐(CREA)、尿酸(UA)、空腹血糖(FBG)。血常规检测:抽取外周静脉血2 mL,至乙二胺四乙酸二钾抗凝管,使用迈瑞-BC3000plus血球分析仪测量白细胞计数(WBC)、红细胞计数(RBC)、血红蛋白(Hb)、红细胞压积(HCT)、红细胞平均体积(MCV)、平均红细胞血红蛋白量(MCH)、平均红细胞血红蛋白浓度(MCHC)、血小板压积(PCT)、血小板计数(PLT)、血小板分布宽度(PDW)、平均血小板体积(MPV)。

1.2.4 MetS诊断标准

参照国际组织联合提供的标准^[9],该定义包括腰围增加,根据我国卫生行业标准《成人体重判定》(WS/T 428—2013),腰围使用男性90 cm,女性85 cm作为界点。若具有以下3项及以上风险因素,则诊断为MetS,①腰围:男性≥90 cm,女性≥85 cm;②空腹TG≥1.7 mmol/L;③HDL-C:男性<1.0 mmol/L,女性<1.3 mmol/L;④高血压:SBP≥130 mmHg和/或DBP≥85 mmHg(1 mmHg=0.133 kPa)(或已接受治疗);⑤高血糖:空腹FBG≥5.6 mmol/L(或已接受治疗)。

1.3 统计学方法

使用SPSS 26.0软件进行统计分析。连续变量用 $\bar{x} \pm s$ 表示;分类变量用百分比(%)表示。采用 t 检验来分析研究对象的特征差异,采用 F 检验分析红细胞参数与MetS组分数量的关系;采用 χ^2 检验比较MetS成分的比例,并比较血常规参数差异对MetS患病率的影响。多因素logistic回归分析与MetS相关的血常规参数的调整比值比(OR)并调整潜在的混杂因素;model 1调整年龄、体质指数(BMI)、饮酒;model 2调整年龄、BMI、饮酒、海拔、居住地、身体活动、教育水平、婚姻状况、就业状况、年医疗费用支出。双侧检验,检验水准 $\alpha=0.05$ 。

2 结果

2.1 一般资料

结果见表1。研究共纳入2832人,平均年龄(46.87±14.38)岁, MetS患病率为11.5%(325/2832),男性12.9%,女性10.6%($\chi^2=3.536, P=0.060$)。与MetS患者相比,未患病

表 1 一般人口学特征
Table 1 General demographic characteristics

Basic information	Total (n = 2832)	Non-MetS (n = 2507)	MetS (n = 325)	χ^2/t	P
Sex/case (%)				3.536	0.060
Male	1 136 (40.1)	990 (39.5)	146 (44.9)		
Female	1 696 (59.9)	1 517 (60.5)	179 (55.1)		
Age/yr.	46.87 ± 14.38	46.23 ± 14.36	53.61 ± 12.68	-10.017	< 0.001
Age/case (%)				68.934	< 0.001
18-45 yr.	1 361 (48.1)	1 258 (50.2)	103 (31.7)		
46-59 yr.	866 (30.6)	768 (30.6)	98 (30.2)		
≥ 60 yr.	605 (21.4)	481 (19.2)	124 (38.2)		
Body mass index/case (%)				240.947	< 0.001
≥ 18.5 kg/m ²	151 (5.3)	147 (5.8)	4 (1.2)		
18.5-23.9 kg/m ²	1 456 (51.4)	1 406 (56.1)	50 (15.4)		
≥ 24.0 kg/m ²	1 225 (43.3)	954 (38.1)	271 (83.4)		
Altitude/case (%)				28.702	< 0.001
≤ 3 700 m	749 (26.4)	638 (25.4)	111 (34.2)		
3 701-4 500 m	1 424 (50.3)	1 306 (52.1)	118 (36.3)		
> 4 500 m	659 (23.3)	563 (22.5)	96 (29.5)		
Smoking status/case (%)				2.304	0.316
Smoker	248 (8.8)	221 (8.8)	27 (8.3)		
Ex-smoker	143 (5.0)	121 (4.8)	22 (6.8)		
Nonsmoker	2 441 (86.2)	2 165 (86.4)	276 (84.9)		
Drinking status/case (%)				8.790	0.012
Drinker	403 (14.2)	348 (13.9)	55 (16.9)		
Ex-drinker	183 (6.5)	152 (6.1)	31 (9.5)		
Nondrinker	2 246 (79.3)	2 007 (80.1)	239 (73.5)		
Residence/case (%)				7.743	0.021
Urban	181 (6.4)	153 (6.1)	28 (8.6)		
Agricultural	1 788 (63.1)	1 571 (62.7)	217 (66.8)		
Pastoral	863 (30.5)	783 (31.2)	80 (24.6)		
Physical exercise/case (%)				20.712	< 0.001
Never	1 562 (55.2)	1 415 (56.4)	147 (45.2)		
Less than once per week	269 (9.5)	237 (9.5)	32 (9.8)		
Once or twice per week	117 (4.1)	93 (3.7)	24 (7.4)		
Three times per week or more	884 (31.2)	762 (30.4)	122 (37.5)		
Education level/case (%)				2.103	0.349
Illiteracy	1 828 (64.5)	1 608 (64.1)	220 (67.7)		
Primary school	597 (21.1)	531 (21.2)	66 (20.3)		
Junior/senior high school and above	407 (14.4)	368 (14.7)	39 (12.0)		
Marital status/case (%)				8.935	0.011
Never married	291 (10.3)	273 (10.9)	18 (5.5)		
Married	2 425 (85.6)	2 132 (85.0)	293 (90.2)		
Divorced/widowhood	116 (4.1)	102 (4.1)	14 (4.3)		
Employment status/case (%)				24.302	< 0.001
Employed	235 (8.3)	199 (7.9)	36 (11.1)		
Retired	52 (1.8)	46 (1.8)	6 (1.8)		
Full-time equivalence	1 150 (40.6)	1 058 (42.2)	92 (28.3)		
Farmers/herdsmen	1 356 (47.9)	1 169 (46.6)	187 (57.5)		
Unemployed	39 (1.4)	35 (1.4)	4 (1.2)		
Annual medical expenses/case (%)				28.697	< 0.001
≥ 500 yuan	1 036 (36.6)	924 (36.9)	112 (34.5)		
501-999 yuan	1 055 (37.3)	948 (37.8)	107 (32.9)		
1 000-2 999 yuan	261 (9.2)	242 (9.7)	19 (5.8)		
3 000-4 999 yuan	169 (6.0)	137 (5.5)	32 (9.8)		
5 000-9 999 yuan	144 (5.1)	116 (4.6)	28 (8.6)		
≥ 10 000 yuan	167 (5.9)	140 (5.6)	27 (8.3)		
Physical examination					
RHR/min ⁻¹	74.90 ± 15.88	74.37 ± 13.03	79.01 ± 29.54	-2.799	0.005
SpO ₂ /%	85.02 ± 17.82	85.15 ± 18.82	84.03 ± 5.84	1.073	0.283

RHR: Resting heart rate; SpO₂: oxygen saturation.

者更年轻, BMI、静息心率、居住地海拔、年医疗支出水平更低, 且无饮酒史, 差异有统计学意义($P<0.05$)。

MetS患者的WC、FBG、TG、SBP、DBP均高于未患病者, HDL-C低于未患病者, 差异有统计学意义($P<$

0.001)。血常规检测显示, MetS患者的WBC、RBC、Hb、HCT、MCV、MCH均高于未患病者, MPV低于未患病者, 差异有统计学意义($P<0.001$); 血生化检测显示, MetS患者的ALT、UA、LDL-C均高于未患病者, 差异有统计学意义($P<0.001$)。见表2。

2.2 血常规指标与MetS风险因素的关系

2.2.1 血常规指标水平与MetS风险因素数量的关系

除MCHC以外, 其余各指标在不同MetS风险因素个

数组间差异均具有统计学意义($P<0.05$), 其中 WBC、RBC、Hb、HCT、MCV、MCH水平随风险因素个数增加呈上升趋势。见表3。

2.2.2 血常规与MetS及其风险因素患病率的关系

MetS患病率随WBC、HCT、MCV、MCH升高呈上升趋势, 差异有统计学意义($P<0.05$)。中心性肥胖随WBC、RBC、Hb、HCT、MCV升高呈上升趋势, 差异有统计学意义($P<0.05$)。而MPV升高, MetS、中心性肥胖患病则呈下

表 2 实验室检查结果
Table 2 Laboratory information

Laboratory tests	Total ($n = 2832$)	Non-MetS ($n = 2507$)	MetS ($n = 325$)	t	P
Components of MetS					
Waist circumference/cm	83.16 ± 10.57	81.50 ± 9.53	95.96 ± 9.36	−25.780	< 0.001
HDL-C/(mmol/L)	1.71 ± 0.59	1.76 ± 0.59	1.34 ± 0.44	15.571	< 0.001
FBG/(mmol/L)	4.68 ± 0.86	4.57 ± 0.68	5.50 ± 1.45	−11.338	< 0.001
TG/(mmol/L)	1.23 ± 0.77	1.13 ± 0.63	2.04 ± 1.16	−13.923	< 0.001
SBP/mmHg	126.15 ± 22.21	123.88 ± 21.27	143.66 ± 21.50	−15.758	< 0.001
DBP/mmHg	83.12 ± 13.82	81.65 ± 13.28	94.42 ± 12.67	−16.401	< 0.001
Hematological parameters					
WBC/($\times 10^9 L^{-1}$)	6.08 ± 1.58	6.04 ± 1.55	6.44 ± 1.73	−4.265	< 0.001
RBC/($\times 10^{12} L^{-1}$)	5.37 ± 0.68	5.35 ± 0.66	5.51 ± 0.77	−3.450	0.001
Hb/(g/L)	163.99 ± 26.17	162.90 ± 25.63	172.45 ± 28.68	−5.717	< 0.001
HCT/%	47.69 ± 10.97	47.15 ± 11.05	51.87 ± 9.34	−7.363	< 0.001
MCV/fL	92.36 ± 7.45	92.07 ± 7.37	94.62 ± 7.67	−5.663	< 0.001
MCH/pg	30.51 ± 2.84	30.41 ± 2.84	31.22 ± 2.76	−4.859	< 0.001
MCHC/(g/L)	330.09 ± 17.03	330.11 ± 16.41	329.91 ± 21.24	0.160	0.873
PLT/($\times 10^9 L^{-1}$)	263.13 ± 73.70	263.92 ± 73.61	257.01 ± 74.21	1.592	0.112
MPV/fL	10.39 ± 2.32	10.46 ± 2.33	9.89 ± 2.23	4.196	< 0.001
PCT/%	0.30 ± 0.09	0.30 ± 0.09	0.29 ± 0.09	1.711	0.088
PDW/fL	14.87 ± 3.01	14.86 ± 3.05	14.88 ± 2.62	−0.104	0.917
Blood Biochemistry					
ALT/(U/L)	29.44 ± 22.14	28.64 ± 21.34	35.62 ± 26.77	−4.518	< 0.001
AST/(U/L)	24.86 ± 13.06	24.82 ± 12.85	25.16 ± 14.58	−0.396	0.693
AST/ALT	1.02 ± 0.43	1.04 ± 0.42	0.86 ± 0.41	7.147	< 0.001
Urea/(mmol/L)	5.32 ± 2.12	5.33 ± 2.05	5.25 ± 2.55	0.495	0.621
CREA/(μ mol/L)	66.39 ± 20.43	66.28 ± 19.77	67.19 ± 24.97	−0.626	0.532
UA/(μ mol/L)	375.23 ± 132.46	369.80 ± 127.34	417.12 ± 160.91	−5.099	< 0.001
TC/(mmol/L)	5.72 ± 1.64	5.71 ± 1.62	5.77 ± 1.78	−0.505	0.614
LDL-C/(mmol/L)	3.04 ± 1.01	3.00 ± 0.99	3.30 ± 1.16	−4.418	< 0.001

WBC: white blood cell count; RBC: red blood cell count; Hb: hemoglobin; HCT: Hematocrit; MCV: mean corpuscular volume; MCH: mean corpuscular hemoglobin; MCHC: mean corpuscular hemoglobin concentration; PLT: platelet count; MPV: mean platelet volume; PCT: Plateletcrit; PDW: platelet distribution width; ALT: alanine aminotransferase; AST: aspartate aminotransferase; CREA: creatinine; UA: uric acid; TC: total cholesterol; LDL-C: low-density lipoprotein cholesterol. 1 mmHg = 0.133 kPa.

表 3 具有不同数量MetS风险因素的研究对象的血常规指标水平

Table 3 The levels of blood routine indicators of the research subjects with different numbers of MetS risk factors

Component quantity	n	WBC/ ($\times 10^9 L^{-1}$)	RBC/ ($\times 10^{12} L^{-1}$)	Hb/(g/L)	HCT/%	MCV/fL	MCH/pg	MCHC/(g/L)	PLT/($\times 10^9 L^{-1}$)	MPV/fL	PCT/%	PDW/fL
0	946	5.91 ± 1.52	5.33 ± 0.59	161.25 ± 24.81	45.95 ± 11.32	91.48 ± 7.23	30.26 ± 2.88	330.27 ± 15.60	270.95 ± 71.73	10.46 ± 2.27	0.31 ± 0.08	14.61 ± 2.89
1	956	6.10 ± 1.58	5.33 ± 0.66	161.87 ± 25.30	46.92 ± 10.90	91.99 ± 7.60	30.36 ± 2.87	329.57 ± 16.54	258.89 ± 71.07	10.54 ± 2.40	0.30 ± 0.09	14.96 ± 3.22
2	605	6.14 ± 1.55	5.44 ± 0.75	167.10 ± 26.96	49.40 ± 10.51	93.12 ± 7.11	30.74 ± 2.70	330.70 ± 17.40	260.88 ± 79.51	10.34 ± 2.32	0.29 ± 0.09	15.10 ± 3.01
≥ 3	325	6.44 ± 1.73	5.51 ± 0.77	172.45 ± 28.68	51.87 ± 9.34	94.62 ± 7.67	31.22 ± 2.76	329.91 ± 21.24	257.01 ± 74.21	9.89 ± 2.23	0.29 ± 0.09	14.88 ± 2.62
F		9.357	9.422	20.128	31.082	17.548	11.605	0.599	5.566	6.818	3.717	3.756
P		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.616	0.001	0.001	0.011	0.010

All the abbreviations in the table are the same as those in Table 2.

降趋势。高血压患病随MCV、MCH、PDW升高呈上升趋势,而随着PLT、PCT升高,高血压呈下降趋势,差异有统计学意义($P<0.05$)。高脂血症随WBC、HCT、MCV升高呈上升趋势,而PDW升高,则呈下降趋势,差异有统计学意义($P<0.05$)。低HDL-C血症随WBC、HCT、PDW升高,患病呈上升趋势,差异有统计学意义($P<0.05$)。高血糖随HCT、MCHC升高,患病呈上升趋势,而随PLT、

PCT、PDW升高,则呈下降趋势,差异有统计学意义($P<0.05$)。见表4。

2.3 血常规与MetS的二元logistic回归分析

以有无MetS为因变量(赋值:否=0、是=1),血常规参数为自变量,进行logistic回归分析(表5)。关于血常规与MetS患病之间的关系,调整潜在的混杂因素(表1中差异有统计学意义的变量):模型1显示,WBC、Hb、HCT、

表 4 血常规指标与MetS及其各组分患病率的关系

Table 4 Relationship between blood routine indicators and the prevalence of metabolic syndrome and its components							
Variable	n	MetS	Central obesity	Hypertension	Hypertriglyceridemia	Low HDL-C syndrome	Hyperglycemia
WBC							
Q1	989	8.5%	26.0%	45.5%	13.8%	12.1%	6.0%
Q2	954	12.4%	29.4%	43.7%	16.7%	13.6%	9.3%
Q3	889	13.8%*	33.9%*	43.3%	21.7%*	19.2%*	7.9%*
RBC							
Q1	955	10.6%	24.6%	47.5%	14.8%	16.6%	6.6%
Q2	936	8.5%	26.4%	40.9%	13.7%	14.2%	5.7%
Q3	941	15.3%*	37.8%*	44.1%*	23.3%*	13.7%	10.8%*
Hb							
Q1	953	10.1%	23.6%	45.5%	14.9%	15.4%	6.8%
Q2	941	8.5%	27.3%	43.5%	13.6%	14.0%	5.8%
Q3	938	15.9%*	38.0%*	43.6%	23.2%*	15.1%	10.4%*
HCT							
Q1	956	7.9%	23.0%	45.8%	11.6%	13.1%	5.2%
Q2	947	10.3%	27.5%	41.4%	17.0%	13.7%	8.7%
Q3	929	16.3%*	38.5%*	45.4%	23.3%*	17.9%*	9.3%*
MCV							
Q1	949	8.0%	25.8%	40.3%	15.4%	12.3%	8.2%
Q2	945	10.7%	28.1%	46.5%	16.6%	10.6%	7.8%
Q3	938	15.8%*	34.9%*	45.9%*	19.7%*	21.7%*	7.0%
MCH							
Q1	995	9.2%	27.4%	42.6%	16.8%	15.3%	7.0%
Q2	936	9.3%	25.6%	42.6%	14.6%	10.5%	8.1%
Q3	901	16.2%*	36.1%*	47.6%*	20.4%*	19.0%*	8.0%
MCHC							
Q1	962	13.1%	29.7%	46.2%	17.4%	22.7%	5.8%
Q2	950	9.1%	27.4%	42.9%	15.8%	10.7%	6.5%
Q3	920	12.3%*	31.7%	43.5%	18.6%	11.0%*	10.9%*
PLT							
Q1	960	13.0%	28.2%	54.5%	19.1%	10.5%	10.5%
Q2	933	13.3%	31.3%	41.9%	16.5%	21.7%	7.1%
Q3	939	8.1%*	29.3%	36.0%*	16.1%	12.6%*	5.4%*
MPV							
Q1	960	15.0%	34.5%	43.8%	17.1%	23.3%	7.0%
Q2	973	9.7%	27.5%	44.4%	15.9%	9.4%	8.7%
Q3	899	9.7%*	26.6%*	44.5%	18.8%	11.8%*	7.3%
PCT							
Q1	944	14.8%	30.4%	54.8%	18.3%	11.5%	11.3%
Q2	944	8.7%	28.6%	42.5%	17.1%	10.6%	5.9%
Q3	944	10.9%*	29.8%	35.4%*	16.3%	22.5%*	5.8%*
PDW							
Q1	965	11.1%	29.3%	40.5%	49.4%	9.7%	9.8%
Q2	927	9.1%	28.4%	42.8%	14.0%	11.3%	6.7%
Q3	940	11.5%*	31.1%	49.4%*	18.2%*	23.6%*	6.5%*

All the abbreviations in the table are the same as those in Table 2. Q1, Q2, and Q3 represent tertiles of erythrocyte parameters, respectively. * $P < 0.05$, comparison among Q1, Q2 and Q3 groups.

表 5 血常规指标与MetS的相关性分析
Table 5 Correlation analysis between blood count parameters and metabolic syndrome

Variable	Model 1		Model 2	
	OR (95% CI)	P	OR (95% CI)	P
WBC				
Q1			Reference	
Q2	1.705 (1.226-2.371)	0.002	1.629 (1.164-2.279)	0.004
Q3	1.664 (1.184-2.339)	0.003	1.621 (1.14-2.292)	0.006
RBC				
Q1			Reference	
Q2	0.907 (0.581-1.416)	0.667	0.884 (0.562-1.392)	0.595
Q3	1.339 (0.750-2.393)	0.324	1.324 (0.734-2.390)	0.351
Hb				
Q1			Reference	
Q2	0.553 (0.343-0.889)	0.015	0.523 (0.325-0.843)	0.008
Q3	0.481 (0.237-0.977)	0.043	0.435 (0.212-0.889)	0.022
HCT				
Q1			Reference	
Q2	1.549 (0.970-2.473)	0.067	1.818 (1.123-2.943)	0.015
Q3	2.069 (1.028-4.162)	0.042	2.480 (1.208-5.089)	0.013
MCV				
Q1			Reference	
Q2	1.124 (0.756-1.673)	0.564	1.092 (0.732-1.629)	0.667
Q3	1.111 (0.650-1.897)	0.701	0.908 (0.524-1.573)	0.731
MCH				
Q1			Reference	
Q2	1.261 (0.824-1.930)	0.286	1.245 (0.810-1.916)	0.318
Q3	1.793 (1.026-3.130)	0.040	1.713 (0.965-3.041)	0.066
MCHC				
Q1			Reference	
Q2	0.697 (0.490-0.991)	0.045	0.724 (0.503-1.042)	0.082
Q3	0.745 (0.498-1.113)	0.151	0.775 (0.512-1.175)	0.230
PLT				
Q1			Reference	
Q2	1.048 (0.689-1.593)	0.826	0.980 (0.638-1.506)	0.928
Q3	0.776 (0.480-1.256)	0.302	0.661 (0.402-1.088)	0.104
MPV				
Q1			Reference	
Q2	0.786 (0.528-1.170)	0.235	0.890 (0.568-1.395)	0.611
Q3	0.754 (0.514-1.108)	0.150	0.971 (0.581-1.623)	0.912
PCT				
Q1			Reference	
Q2	0.771 (0.522-1.139)	0.192	0.809 (0.540-1.213)	0.306
Q3	0.800 (0.516-1.241)	0.320	0.877 (0.551-1.398)	0.582
PDW				
Q1			Reference	
Q2	0.673 (0.455-0.995)	0.047	0.562 (0.358-0.881)	0.012
Q3	0.809 (0.547-1.197)	0.289	0.614 (0.381-0.991)	0.046

OR: odds ratio. All the other abbreviations in the table are the same as those in Table 2. Model 1 was adjusted for age, BMI, and alcohol consumption; model 2 was adjusted for age, BMI, alcohol consumption, altitude, place of residence, physical activity, education level, marital status, employment status, and annual health care expenditure.

MCH、MCHC、PDW与MetS患病有关。与最低的三分位数组Q1相比，WBC的Q2、Q3组的OR值分别为1.705〔95%置信区间（CI）：1.226 ~ 2.371， $P=0.002$ 〕和1.664（95%CI: 1.184 ~ 2.339, $P=0.003$ ）；Hb的Q2、Q3组的OR值分别为0.553（95%CI: 0.343 ~ 0.889, $P=0.015$ ）和0.481（95%CI: 0.237 ~ 0.977, $P=0.043$ ）；HCT的Q3组的OR值为2.069（95%CI: 1.028 ~ 4.162, $P=0.042$ ）；MCH的Q3组的OR值为1.793（95%CI: 1.026 ~ 3.130, $P=0.040$ ）；MCHC的Q2组的OR值为0.697（95%CI: 0.490 ~ 0.991, $P=0.045$ ）；PDW的Q2组的OR值为0.673（95%CI:

0.455 ~ 0.995, $P=0.047$)。模型2显示, WBC、Hb、HCT、PDW与MetS患病有关。与最低的三分位数组Q1相比, WBC的Q2、Q3组的OR值分别为1.629(95%CI: 1.164 ~ 2.279, $P=0.004$)和1.621(95%CI: 1.14 ~ 2.292, $P=0.006$); Hb的Q2、Q3组的OR值分别为0.523(95%CI: 0.325 ~ 0.843, $P=0.008$)和0.435(95%CI: 0.212 ~ 0.889, $P=0.022$); HCT的Q2、Q3组的OR值分别为1.818(95%CI: 1.123 ~ 2.943, $P=0.015$)和2.480(95%CI: 1.208 ~ 5.089, $P=0.013$); PDW的Q2、Q3组的OR值分别为0.562(95%CI: 0.358 ~ 0.881, $P=0.012$)和0.614(95%CI: 0.381 ~ 0.991, $P=0.046$)。

3 讨论

我国不同民族标准化MetS患病率从6.18%到35.43%不等, 具有差异性, 其中藏族为6.17%^[10]。本研究纳入的藏族人群MetS患病率为11.5%, 且在性别间无统计学差异。可能与文化行为、生活习惯以及诊断标准有关, 不同性别间的代谢稳态在脂肪储存、葡萄糖稳态受性不对称等某些方面的调节方式不同, 同时MetS标准的不同组合与不同的肠道菌群失调有关, 因此可能阻碍性别差异的识别^[11-12]。MetS患病率随年龄增长呈上升趋势, 可能与衰老通过复杂的病理生理机制增加MetS的风险有关, 40岁可能是MetS一级预防的关键时间点^[13]。当海拔超过4500 m, MetS患病率最低。可能与高海拔居民存在遗传变异与缺氧适应多态性有关^[14]。MetS患者RHR处于较高水平, MetS的风险随着RHR的增加而增加。可能通过影响BP、TG和FBG而产生, 提示RHR可能是MetS、糖尿病等代谢紊乱的潜在治疗靶点^[15]。

除MCHC外, 参与者的WBC、RBC、Hb、HCT、MCV、MCH水平随MetS风险因素个数增加而升高。MCHC与高TG、低HDL-C有关, 可能是MetS的早期预测指标^[16]。大多数血常规指标水平的增加与更高的胰岛素抵抗相关^[17-19]。而胰岛素抵抗作为MetS病理生理基础, 已被证实与MetS组分数呈正相关^[20-21]。MetS患者的WBC、RBC、Hb、HCT、MCV、MCH水平均高于未患病者, MPV水平低于未患病者, 结果与一项横断面研究相似^[22], 但在该研究中MetS患者PLT水平高于未患病者, 而本研究两组PLT水平差异无统计学意义。长期暴露于高海拔环境会导致PLT降低, 这可能与高海拔引起的慢性低氧血症有关, 进而影响PLT的生成和功能^[23]。血小板参数中, 低水平的MPV可以增加PLT计数, 这反过来又最终导致MetS的发展^[24]。血常规指标中, HCT与中心性肥胖、高TG血症、低HDL-C血症、高血糖呈正相关,

WBC与前三者均呈正相关, 其他指标仅与MetS风险因素中的1~3种存在关联。

综合logistic回归结果, WBC、Hb、HCT、PDW与MetS患病风险有关, WBC和HCT为MetS患病的危险因素; Hb和PDW为保护因素。WBC在炎症和免疫反应中起关键作用, 胰岛素抵抗和慢性炎症与MetS相关, 通过合成一些细胞因子导致WBC计数增加^[25]。MetS患病率与HCT水平的显著增加有关^[26]。高海拔地区会引起HCT升高, 这与脱水、红细胞增多症有关^[27], 导致血液黏稠度增加, 影响血流动力学, 引起代谢性疾病。高水平的Hb是两性MetS发病率的潜在预测因子, Hb水平升高与发生MetS风险之间不一定存在直接的因果关系^[16]。即使在世界卫生组织正常的血红蛋白范围, 死亡风险梯度随着Hb水平的增加而降低^[28]。PDW的平均值在MetS合并糖尿病患者以及健康对照组之间存在显著差异, 这可能表明PDW在MetS的发生和发展中可能起到一定的作用^[29], 但PDW能否作为预测指标有待更深入的研究。

代谢性疾病患病率和亚型模式在世界范围内的不同民族间存在明显差异, 个性化的管理和预防目标应被纳入疾病防控的有效策略中, 以降低代谢紊乱的风险^[30]。血液学参数的测量在世界大部分地区都很容易获得, 但在公共卫生政策中, 该参数在MetS患者的诊断和治疗中未被考虑, 可能给全球卫生系统带来经济消耗和社会成本。因此, 可以考虑血常规参数像其他危险因素(如高脂血症、高血压)一样成为临床干预的新目标, 作为管理和控制类似慢性病的一种高效指标。

本研究也存在一些局限性: ①横断面研究无法推断因果关系、时间变化趋势, 故外推至其他族群需谨慎, 需要多中心、前瞻性队列研究验证。②可能存在未测量的混杂因素无法在模型中调整。③未考虑饮食策略、遗传因素, 需要整合基因-环境交互分析、建立多维度预测模型。

综上, 西藏藏族人群MetS患病率低于国内水平, WBC、Hb、HCT、PDW平均水平与MetS患病风险有关, 其中WBC和HCT为MetS患病的危险因素; Hb和PDW为保护因素, 建议将血常规作为一种简单、有效的指标纳入代谢性疾病管理和控制。

* * *

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data curation, formal analysis, methodology, and writing--original draft. ZHANG Yufei is responsible for data curation and investigation. ZHANG Jing is responsible for investigation and supervision. WAN Yang is responsible for supervision and writing--review and editing. XIONG Hai is responsible for conceptualization, funding acquisition, methodology, supervision, and writing--review and editing. All authors consented to the submission of the article to the Journal. All authors approved the final version to be published and agreed to take responsibility for all aspects of the work.

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