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# Sleep Quality, Nutrient Intake, and Social Development Index Predict Metabolic Syndrome in the Tlalpan 2020 Cohort: A Machine Learning and Synthetic Data Study

**Guadalupe Gutiérrez-Esparza [1,2,*,†], Mireya Martinez-Garcia [3,†], Tania Ramírez-delReal [4], Lucero Elizabeth Groves-Miralrio [3], Manlio F. Marquez [5], Tomás Pulido [6], Luis M. Amezcua-Guerra [3] and Enrique Hernández-Lemus [7,8,*]**

1 Researcher for Mexico CONAHCYT, National Council of Humanities, Sciences and Technologies, Mexico City 08400, Mexico
2 Clinical Research, National Institute of Cardiology 'Ignacio Chávez', Mexico City 14080, Mexico
3 Department of Immunology, National Institute of Cardiology 'Ignacio Chávez', Mexico City 14080, Mexico
4 Center for Research in Geospatial Information Sciences, Aguascalientes 20313, Mexico
5 Department of Electrocardiology, National Institute of Cardiology 'Ignacio Chavez', Mexico City 14080, Mexico
6 Cardiopulmonary Department, National Institute of Cardiology 'Ignacio Chávez', Mexico City 14080, Mexico
7 Computational Genomics Division, National Institute of Genomic Medicine, Mexico City 14610, Mexico
8 Center for Complexity Sciences, Universidad Nacional Autónoma de Mexico, Mexico City 04510, Mexico
* Correspondence: ggutierreze@conacyt.mx (G.G.-E.); ehernandez@inmegen.gob.mx (E.H.-L.)
† Co-first authors.

**Abstract:** This study investigated the relationship between Metabolic Syndrome (MetS), sleep disorders, the consumption of some nutrients, and social development factors, focusing on gender differences in an unbalanced dataset from a Mexico City cohort. We used data balancing techniques like SMOTE and ADASYN after employing machine learning models like random forest and RPART to predict MetS. Random forest excelled, achieving significant, balanced accuracy, indicating its robustness in predicting MetS and achieving a balanced accuracy of approximately 87%. Key predictors for men included body mass index and family history of gout, while waist circumference and glucose levels were most significant for women. In relation to diet, sleep quality, and social development, metabolic syndrome in men was associated with high lactose and carbohydrate intake, educational lag, living with a partner without marrying, and lack of durable goods, whereas in women, best predictors in these dimensions include protein, fructose, and cholesterol intake, copper metabolites, snoring, sobbing, drowsiness, sanitary adequacy, and anxiety. These findings underscore the need for personalized approaches in managing MetS and point to a promising direction for future research into the interplay between social factors, sleep disorders, and metabolic health, which mainly depend on nutrient consumption by region.

**Keywords:** poor quality sleep; social development index; nutrients; machine learning; features selection; balancing methods; Mexico City; Tlalpan 2020 cohort



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**Table S1.** Results of logistic regression in women sorted in descending order by coefficient

| Variable | Coeficient | P_value |
|---|---|---|
| GLU | 4.61438598 | 6.24E-59 |
| TRIG | 3.63418178 | 1.18E-37 |
| WC | 1.75532078 | 2.86E-09 |
| BMI | 1.60919304 | 1.05E-06 |
| SBP | 1.40299133 | 1.15E-12 |
| PROTEI | 0.90748897 | 0.08529715 |
| FRUCT | 0.73077934 | 0.23874313 |
| CHOL_SN | 0.72037259 | 0.06868106 |
| URIC | 0.65547784 | 0.01333401 |
| CU | 0.64813271 | 0.17111299 |
| ST | 0.58453044 | 0.06673992 |
| TAKENAP | 0.52306921 | 0.08428453 |
| TFATAV | 0.45378438 | 0.50511738 |
| SLP6 | 0.45257216 | 0.31634152 |
| AFAT | 0.40353617 | 0.39285846 |
| SNORE | 0.40096519 | 0.03765119 |
| SLP9 | 0.39875326 | 0.51090309 |
| SMOKING | 0.39656832 | 0.57622716 |
| HEIGHT | 0.36843397 | 0.3602053 |
| VITD | 0.34565731 | 0.19293713 |
| EXSMOKER | 0.32652526 | 0.11109861 |
| INSFB | 0.31650888 | 0.45212319 |
| LACT | 0.31406159 | 0.42909475 |
| AGE | 0.26491293 | 0.17849854 |
| PH | 0.26443511 | 0.68096902 |
| VFAT | 0.26247553 | 0.58626792 |
| MALT | 0.20732745 | 0.50183824 |
| IAT | 0.20506743 | 0.479725 |
| RETINOL | 0.18177015 | 0.68232155 |
| SUCR | 0.18008465 | 0.51158553 |
| STYAWKE | 0.1617628 | 0.54163095 |
| CHOL_ANT | 0.15962587 | 0.71856375 |
| IRON | 0.15816576 | 0.76953296 |
| K | 0.15479984 | 0.81570532 |
| B1 | 0.11950575 | 0.83439004 |
| BREATH | 0.11727516 | 0.7376083 |
| VITE | 0.11675957 | 0.70161142 |
| B6 | 0.08788424 | 0.86343227 |
| CAFF | 0.07777266 | 0.72971541 |
| TROBLS | 0.07165834 | 0.84037238 |
| SODIUM | 0.06499431 | 0.86254147 |
| POLY | 0.06264591 | 0.85856365 |
| SLPQRAW | 0.0603044 | 0.8127478 |
| SLPSOB1 | -0.0185385 | 0.96462192 |
| CURRENT | -0.01938308 | 0.97413252 |
| TRAIT_ANX | -0.02819937 | 0.90004735 |
| MAGN | -0.03600824 | 0.95688876 |
| SLPOP1 | -0.0400532 | 0.84178799 |
| NA. | -0.04293846 | 0.8740068 |
| VITC | -0.05132443 | 0.88725477 |
| LDLCO | -0.05927508 | 0.8952959 |

**Table S1 continued from previous page**

| | | |
|---|---|---|
| CALOR | -0.13207227 | 0.87598952 |
| B12 | -0.1445629 | 0.77639742 |
| SOLFB | -0.14880699 | 0.69465531 |
| CALC | -0.16159519 | 0.7565454 |
| CRUDE | -0.19893755 | 0.67623461 |
| STAT_ANX | -0.20092121 | 0.36918723 |
| SLPNOTQ | -0.21249549 | 0.41886259 |
| VITK | -0.23625609 | 0.5414399 |
| SMO_PASS | -0.23627251 | 0.4685682 |
| ALCOHOL | -0.24089496 | 0.1195537 |
| ALCO | -0.26775646 | 0.53730363 |
| SLPA2 | -0.2687622 | 0.20739717 |
| SLPS3 | -0.28663189 | 0.50885402 |
| AWAKEN | -0.34580742 | 0.24386794 |
| HEMCL | -0.34734947 | 0.26516726 |
| DROWSY | -0.3479991 | 0.22112597 |
| ZN | -0.39223322 | 0.40230761 |
| TOTMET | -0.40208434 | 0.08124107 |
| MN | -0.47366817 | 0.10230907 |
| SE | -0.48288291 | 0.16724211 |
| SLPD4 | -0.57325002 | 0.27193455 |
| GLU_1 | -0.60657151 | 0.29639836 |
| CREA | -0.60735014 | 0.11428968 |
| SATFAT | -0.61803943 | 0.34013618 |
| B2 | -0.67127121 | 0.23709781 |
| APROT | -0.72667515 | 0.16289713 |
| MONFAT | -0.73209194 | 0.17033049 |
| WEIGHT | -1.0528151 | 0.00522037 |
| CARBO | -1.26566017 | 0.0287169 |
| (Intercept) | -3.4369688 | 5.37E-29 |
| HDLCO | -4.67800035 | 4.34E-30 |

**Table S2.** Results of logistic regression in men sorted in descending order by coefficient

| Variable | Coeficient | P_value |
|---|---|---|
| GLU | 3.94711748 | 2.45E-39 |
| TRIG | 2.98165065 | 3.25E-24 |
| WC | 2.53131848 | 1.02E-09 |
| IAT | 2.06238741 | 5.13E-11 |
| SBP | 1.53063308 | 1.31E-11 |
| B12 | 1.41903991 | 0.00880359 |
| BMI | 1.40229014 | 0.00087404 |
| LACT | 1.29691863 | 0.00581383 |
| CARBO | 1.18935354 | 0.0886463 |
| GLU_1 | 1.1674073 | 0.10024746 |
| CU | 0.86241521 | 0.19720812 |
| CRUDE | 0.73023815 | 0.26052964 |
| SE | 0.71701752 | 0.07045393 |
| SOLFB | 0.68892284 | 0.11226852 |
| SLPS3 | 0.63231119 | 0.23874266 |
| B6 | 0.56405727 | 0.35640401 |
| CAFF | 0.55851073 | 0.03728065 |

**Table S2 continued from previous page**

| | | |
|---|---|---|
| HEIGHT | 0.55646599 | 0.101185 |
| URIC | 0.50027773 | 0.05583058 |
| SLP6 | 0.49018494 | 0.42527391 |
| B2 | 0.471985 | 0.43641829 |
| TFATAV | 0.39187336 | 0.59775244 |
| SLPSOB1 | 0.38795715 | 0.49319732 |
| TROBLS | 0.35719897 | 0.42334118 |
| STAT_ANX | 0.31595203 | 0.29914662 |
| VFAT | 0.26279143 | 0.64973673 |
| NA. | 0.22975763 | 0.42323475 |
| PH | 0.2199618 | 0.74901992 |
| SLPNOTQ | 0.20605662 | 0.54321397 |
| AWAKEN | 0.16578114 | 0.65939078 |
| SLPQRAW | 0.15883477 | 0.66279526 |
| SMOKING | 0.13175758 | 0.86426917 |
| SLPOP1 | 0.10871661 | 0.6832381 |
| AFAT | 0.07662414 | 0.87999274 |
| SNORE | 0.05505988 | 0.79733064 |
| SODIUM | 0.04176903 | 0.92002409 |
| EXSMOKER | 0.03864623 | 0.86230051 |
| SMO_PASS | -0.02018857 | 0.95202882 |
| TAKENAP | -0.02833024 | 0.94205694 |
| APROT | -0.03904016 | 0.94254801 |
| B1 | -0.03954193 | 0.95075033 |
| VITC | -0.04315616 | 0.9232486 |
| VITE | -0.0460136 | 0.91292523 |
| POLY | -0.04636712 | 0.91422152 |
| MALT | -0.05420069 | 0.88162302 |
| VITK | -0.05740398 | 0.91036994 |
| TOTMET | -0.0581952 | 0.82892443 |
| MN | -0.07280086 | 0.8478548 |
| IRON | -0.11372917 | 0.86265895 |
| TRAIT_ANX | -0.12951548 | 0.69918749 |
| AGE | -0.13556037 | 0.58166301 |
| CURRENT | -0.14013162 | 0.82457946 |
| HEMCL | -0.16034084 | 0.69891929 |
| K | -0.19400137 | 0.80012794 |
| ALCOHOL | -0.20071661 | 0.37849732 |
| CALOR | -0.22980446 | 0.78894578 |
| CHOL_SN | -0.23654431 | 0.5734099 |
| SLPD4 | -0.25183695 | 0.71281377 |
| SLPA2 | -0.28227907 | 0.26369716 |
| INSFB | -0.28725811 | 0.61014935 |
| SLP9 | -0.29043375 | 0.72939731 |
| HDLCO | -0.31881753 | 0.65211129 |
| ST | -0.34077543 | 0.36582727 |
| CREA | -0.3831114 | 0.13099692 |
| BREATH | -0.41692164 | 0.36786663 |
| MONFAT | -0.44628148 | 0.45738033 |
| DROWSY | -0.45651035 | 0.21491969 |
| ALCO | -0.45695453 | 0.10648652 |
| SUCR | -0.47759461 | 0.16370051 |
| MAGN | -0.52591754 | 0.51402708 |

**Table S2 continued from previous page**

| | | |
|---|---|---|
| PROTEI | -0.57765716 | 0.37021573 |
| CALC | -0.58463238 | 0.321778 |
| SATFAT | -0.62107309 | 0.37914123 |
| WEIGHT | -0.63573083 | 0.24061549 |
| VITD | -0.73962226 | 0.03904902 |
| STYAWKE | -0.80478525 | 0.01359924 |
| CHOL_ANT | -0.85126984 | 0.03210061 |
| LDLCO | -0.91851194 | 0.03526427 |
| ZN | -0.9776362 | 0.10372908 |
| RETINOL | -1.16831246 | 0.03750744 |
| FRUCT | -1.60281909 | 0.02964749 |
| (Intercept) | -6.91054671 | 1.44E-33 |