Przegląd Antropologiczny – Anthropological Review • Vol. 66, 87-93 (2003)

https://doi.org/10.18778/1898-6773.66.07

Morphological classification of patients with sleep obstructive disturbances

Blanka Mrowicka,[1] *Magdalena Kosińska,*[1] *Szczepan Cofta*[2]

[1] Institute of Anthropology, Adam Mickiewicz University, Fredry 10, 61-701 Poznań, Poland; E-mail: blanka@amu.edu.pl
[2] Chair and Department of Phtysiopneumonology, Academy of Medical Sciences, Szamarzewskiego 84, 60-569 Poznań

ABSTRACT It has been suggested that enlarged values of morphological measurements manifesting obesity intensify the risk of sleep disturbances. The main goal of this work was to find a set of predictor morphometric variables that best distinguish between the mutually exclusive groups of interest, the well and the ill – i.e., those who suffer from obstructive sleep apnoea (OSA) syndrome, and healthy patients. Somatic measurements of 96 males were taken. To analyze the dependencies between the degree of intensity of the studied pathology (oxygen desaturation index) and the values of the somatic measurements, the discriminant function analysis was applied. The use of this method allowed obtaining a set of sleep obstructive disturbance predictors. The correctness of classification into the group of healthy individuals was estimated at 81.4%, while correctness of classification into the group of OSA was estimated at 91.3%. The results showed that somatic measurements could be used as a preliminary index of individuals requiring further examination.

KEY WORDS sleep apnoea, somatometry, discriminant function, obesity

Prz. Antropol.–Anthropol. Rev. (2003), vol. 66, pp. 87-93, Fig. 1, Tables 3. ISBN 83-86969-92-X, ISSN 0033-2003

Introduction

Obstructive sleep apnoea (OSA) syndrome is the pathology characterized by cessation of breathing during sleep. Sleep disturbances have a negative influence on the functions of the organism causing tiredness, sleeplessness, morning headaches, disorders in orientation [GREENBERG *et al.* 1987, JENUUM and BORGESEN 1989, FIRLIK and COFTA 1993]. By contributing to morbidity and mortality this pathology can be a very serious medical condition [HE *et al.* 1988, PARTINEN and GUILLEMINAULT 1990]. Moreover it causes many social problems (conflicts at work, family and friends, crashes). OSA affects between 3% and 6% of the adult population [ZIELIŃSKI 1993].

Structural disorders of the upper airway and malformations of the mandible recorded in OSA patients and excessive obesity [LUGARESI *et al.* 1990] often accompanies or is even the basis of OSA. Researchers suggest that enlarged values of morphological measurements, manifesting in obesity intensify the risk of this illness [LUCE 1980, LOPOTA and ONAL 1982, STRADLING and CROSBY 1991, KOSIŃSKA *et al.* 1996, KACZMAREK and MŁYNARCZYK 2002].

In studying medical problems researchers are interested in identifying the risk factors and determining which individuals belong to the risk groups. The occurrence and degree of sleep apnoea syndrome are estimated by somnographic determination. As an expression of the degree of OSA the Oxygen Desaturation Index (ODI) is accepted. This index determines the mean number of desaturations per hour within a period of six hours. However, determination of illness based on the somnographic method is rather expensive, so it would be very worthwhile to find another set of variables relevant to individuals with OSA thereby allowing a prediction for further medical procedures. The set of variables, which seems to be reliable predictors, is the questionnaire [BLIWISE *et al.* 1991] and somatic measurements, especially measurements that are indicators of obesity. Researchers are often interested in the choice of a limited number of variables and correlations among them.

The main goal of this work was to find a set of predictor morphometric variables that best distinguish between the mutually exclusive groups of interest, the well and the ill – OSA and healthy individuals.

Materials and methods

The data are somatic measurements of 96 males hospitalised in the Chair and Department of Phtysiopneumonology of the Academy of Medical Sciences in Poznań, Poland. For this group basic statistics of somatometric traits were calculated. Somatometric variables were measured on patients while awake, with the use of GPM anthropometric instruments. Measurements were taken according to the techniques introduced by Martin and Saller in 1957 [MALINOWSKI and WOLAŃSKI 1988].

Body height and its parts were measured in a standing position with accuracy up to 1 mm, body circumferences measured with an accuracy of 5 mm, body weight with an accuracy of up to 100 g and skinfolds with accuracy of 1 mm. The protocol comprized the following measurements: total body height (*B-v*) and body mass, shoulder breadth (*a-a*), transverse chest breadth (*thl-thl*), sagittal chest depth (*xi-ths*), pelvis breadth (*ic-ic*), circumferences (of the neck, chest, abdomen, thigh, calf, arm, forearm) and skinfolds (cheek, chin, auxillary, triceps, subscapular, rib, abdominal, trunk).

The severity of obstructive sleep apnoea was quantified in terms of the ODI. According to the value of ODI, two groups of individuals were distinguished: (1) – healthy persons: ODI less than thirty, and (2) – OSA persons: ODI equal to and more than thirty.

To analyze the dependencies between the degree of intensity of the studied pathology (ODI) and the values of the somatic measurements the discriminant function analysis was applied. Discriminant analysis is a multivariate statistical technique, which arrives at the weighted combination of a set of predictor variables that best distinguishes between specified groups within a sample of a known diagnosis. Obtained discriminant functions can be used to predict the group of membership of unknown cases. This method, from the computational point of view, is very similar to the multivariate analysis of variance (MANOVA) and requires the same assumptions.

From the group of 96 males, the data of 78 individuals were used to select the morphometric predictors and estimate the discriminant function. The data of 18 randomly chosen individuals were treated as a control group. Throughout the work the forward stepwise analysis was applied. All statistical analyses were performed using the statistical software package Statistica (StatSoft, Inc. 2000).

Results

The basic statistics of somatometric traits are shown in Table 1. As a result of the conducted analysis seven somatometric traits were included in the model of the discriminant function (Table 2). The majority of them (skinfolds and circumferences) are correlated with obesity. In Figure 1 values of the canonical variable for two groups of studied individuals were projected.

Table 1. Descriptive statistics of somatometric traits (body mass in kg, all other measurements in mm)

Somatometric trait	Mean	SD	Min.	Max.
Body mass	95.5	16.6	64.0	130.0
Body height	1736	63	1588	1869
Biacromial (shoulder) breadth	398	22	344	1456
Transverse chest breadth	326	27	274	392
Biiliac (pelvis) breadth	323	27	264	394
Sagittal chest depth	254	33	170	332
Neck circumference	428	32	365	510
Chest circumference	1073	103	840	1350
Abdomen circumference	1079	134	750	1450
Thigh circumference	532	54	360	640
Calf circumference	391	39	300	480
Upperarm circumference	333	33	240	410
Forearm circumference	287	26	210	340
Check skinfold	16.9	5.4	6.0	39.0
Chin skinfold	10.7	7.2	3.0	39.0
Auxillary skinfold	25.5	11.1	4.8	60.0
Triceps skinfold	17.5	12.5	5.4	64.0
Subscapular skinfold	27.6	12.3	6.4	62.0
Rib 10 skinfold	25.7	13.3	4.8	66.0
Abdominal skinfold	26.3	11.8	5.8	65.0
Trunk skinfold	24.8	12.9	5.2	66.0

Table 2. Summary of discriminant function analysis

Wilks' Lambda: 0.4719; $F_{(7,54)} = 8.6321$; $p < 0.0000$			
Somatometric trait	p-level	Tolerance	R^2
Neck circumference	0.00	0.39	0.61
Subscapular skinfold	0.04	0.31	0.69
Sagittal chest depth	0.01	0.49	0.51
Biacromial breadth	0.01	0.74	0.26
Arm circumference	0.02	0.43	0.57
Trunk skinfold	0.09	0.50	0.50
Rib skinfold	0.22	0.29	0.71

Use of the discriminant function analysis enabled the classification functions to be calculated (equations 1, 2). These functions may be applied to determine to which group the studied individuals belong:

(1) healthy persons

$h_1(x) = -416.993 + 9.6a - 1.126b - 0.25c + 1.434d - 3.621e + 30.214f - 0.341g$

(2) OSA persons

$h_2(x) = -462.825 + 10.457a - 0.977b - 0.294c + 1.502d - 4.113e + 32.5f - 0.416g$

where the following abbreviations were used: a – neck circumference, b – subscapular skinfold, c – sagittal chest depth, d – biacromial breadth, e – arm circumference, f – trunk skinfold, g – rib skinfold.

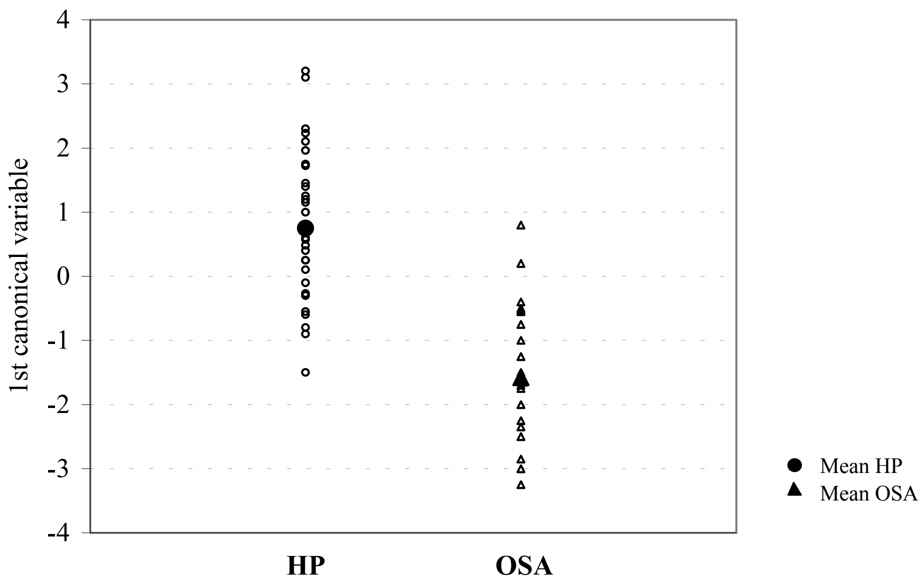

Fig. 1. Projection of canonical variable values for two groups of individuals (HP – healthy persons, and OSA – patients with OSA syndrome).

To assign an individual to the group of healthy persons or to the group of OSA persons both functions (1 and 2) should be calculated. The higher of the two values h (h_1 or h_2) indicates the group into which an individual is classified. The validity of classification, as computed on the above functions, for the group of healthy individuals (h_1) was estimated at 81.4%, while that for the group of ill individuals (h_2) was estimated at 91.3% (Table 3).

Table 3. Classification matrix

Group	Classified as healthy (*N*)	Classified as ill (*N*)	Correctness (%)
Healthy	35	8	81.40
OSA	2	21	91.30
Total	37	29	84.85

The choice of predictor variables executed by using the discriminant function analysis suffers in practice from two general drawbacks. First it is often estimated on the basis of samples limited in numbers that is characteristic of many medical studies. Secondly, the functions are computed *post hoc*; they are obtained on the basis of individuals classified earlier. Moreover, the correctness of the classification was evaluated on the basis of cases from which the discriminant function analysis was calculated.

Thus the question is raised about the adequacy of using indicated variables as predictors of OSA. To verify the choice of predictor variables and the real correctness of classification, a randomly chosen group of individuals ($N = 18$) was used. The classification of those 18 cases to the ODI groups was based on the computed functions. It revealed that 14 persons (77.8%) had been classified correctly. In the case of ill individuals 60% of the decisions taken were correct. For healthy individuals correct decisions were made in 100% of cases.

Discussion

Many studies have been based on a large set of different variables relevant to an individual's condition. As computer techniques have become widely available, studying the complicated character of interdependencies among them and indicating factors determining the analyzed phenomena has become easier. However, it is particularly important to indicate the reduced amount of really significant parameters. This is especially related to defining the limited set of variables that can classify individuals for further medical procedures and, moreover, is concerned both with the prophylactic and with the economical aspect.

In the light of the obtained results a limited number of somatic measurements were chosen. It was found that circumferences (neck and arm) and skinfolds (subscapular, trunk and rib) were significantly correlated with ODI. Significant correlation was also found between ODI and sagittal chest depth and shoulder breadth (see Table 2). Including variables, describing the values of circumferences and skinfolds in the model of discriminant analysis confirms the influence of obesity on the severity of the studied pathology. Other variables, included in the model, are not directly correlated with the obesity. However, the great obesity of the studied individuals may cause the extension of the measurement values of these variables. The results of somatometric investigations may suggest that obesity is one of possible factors responsible for the severity of the disease. The argument for the coexistence of obesity and OSA is based on the fact that a decrease of body weight by 10–15 kg causes a decrease in the number and duration of apnoea episodes [KOWALSKI *et al.* 1993]. The studies conducted confirmed the significant relationship between physical signs of the disease and adiposity, in particular the adiposity of the upper body parts.

The inclusion of the neck circumference in the model as the first variable is noteworthy. Other authors have suggested that this variable is correlated to a large extent with OSA [STRADLING and CROSBY 1991, FLEETHAM 1992], so the obtained results confirm their assertions. The neck circumference seems to be an unquestionable indicator of OSA, as has been confirmed by results of our previous studies. It was found that the degree of OSA increases in individuals with neck circumference values exceeding by at least two standard deviations the population mean [KOSIŃSKA *et al.* 1996]. A considerable increase in the amount of adipose tissue in the neck area can result in changes in pressure or the degeneration of the fatty muscle of this area and the destruction of nerve tissue [KOWALSKI *et al.* 1993].

In conclusion, it is suggested that the probability of correctly classifying individuals with the studied pathology (OSA) on the basis of somatometric traits' set is quite large. However, there exists also the possibility of making an erroneous decision. Hence, the use of the chosen morphological variables and computed classification functions as the only preliminary medical procedure seems to be insufficient. The question concerning the cause of incorrect decisions in the case of unhealthy individuals is raised. It should be emphasized that the studied somatometric traits are polygenic and characterized by continuous variability. These quantitative traits are always more or less ecosensitive. The phenotypic picture of these traits reflects both the polygenic character of determination and the modifying influence of environmental factors. Each of these morphological traits can be situated in a different place in the range of population variability. Values of somatometric traits and the obtained classification functions classify the studied individuals into two groups. There is, however, a common area of overlap and resulting simply from interindividual variability.

References

BLIWISE D.L., J.C. NEKICH, W.C. DEMENT, 1991, *Relative validity of self-reported snoring as a symptom of sleep apnea in a sleep clinic population*, Chest, **99**, 600-8

FIRLIK M., S. COFTA, 1993, *Zespół bezdechu sennego*, Nowiny Lekarskie, **64**, 111-18

FLEETHAM J.A., 1992, *Upper airways imaging in relation to obstructive sleep apnea*, Clinics in Chest Medicine, **13**, 399-416

GREENBERG G.D., R.K. WATSON, D. DEPTULA, 1987, *Neuropsychological dysfunction in sleep apnea*, Sleep, **10**, 254-62

HE J., M.H. KRYGER, F.J. ZORICK, W. CONWAY, T. ROTH, 1988, *Mortality and apnea index in obstructive sleep apnea. Experience in 385 male patients*, Chest, **94**, 9-14

JENUUM P., S.E. BORGESEN, 1989, *Intracranial pressure and obstructive sleep apnea*, Chest, **95**, 279-83

KACZMAREK M., W. MŁYNARCZYK (eds.), 2000, *Zaburzenia snu – zespół obturacyjnego bezdechu sennego*, Monografie Inst. Antropologii UAM, **7**, Poznań

KOSIŃSKA M., B. MROWICKA, S. COFTA, M. RZYMKOWSKA, 1996, *Ocena charakteru cech* *morfologicznych osób z zespołem obturacyjnego bezdechu sennego*, Pneumonologia i Alergologia Polska, **64**, 295-302

KOWALSKI J., T. PRZYBYŁOWSKI, W. DROSZCZ, 1993, *Leczenie obturacyjnego bezdechu sennego*, Pneumonologia i Alergologia Polska, **61**, suppl. 1, 43-7

LOPOTA M., E. ONAL, 1982, *Mass loading, sleep apnea, and the pathogenesis of obesity hypoventilation*, Am. Rev. Respir. Dis., **126**, 640-45

LUCE J.M., 1980, *Respiratory complications of obesity*, Chest, **78**, 626-31

LUGARESI E., F. CIRIGNOTTA, R. GERERDI, P. MONTAGNA, 1990, *Snoring and sleep apnea: Natural history of heavy snorers disease*, [in:] *Obstructive Sleepa Apnea: Clinical Research and Treatment*, C. Guilleminault & M. Partinen (eds.), New York, Raven Press, pp. 25-36

MALINOWSKI A., N. WOLAŃSKI, 1988, *Metody badań w biologii człowieka. Wybór metod antropologicznych*, PWN, Warszawa

PARTINEN M., C. GUILLEMINAULT, 1990, *Daytime sleepiness and vascular morbidity at seven-year follow-up in obstructive sleep apnea patients*, Chest, **97**, 27-32

STRADLING J.R., J.H. CROSBY, 1991, *Predictors and prevalence of obstructive sleep apnoea and snoring in 1001 middle aged man*, Thorax, **46**, 85-90

Streszczenie

Zespół obturacyjnego bezdechu sennego (obstructive sleep apnoea – OSA syndrome) jest często spotykanym zaburzeniem snu. Powszechnie twierdzi się, że ryzyko tych zaburzeń wzrasta w wyniku otyłości. Celem pracy było wskazanie zbioru zmiennych morfologicznych, które pozwalają na prawidłową klasyfikację osób do badań medycznych (polisomnograficznych). Badaniom antropometrycznym i polisomnograficznym poddano 96 mężczyzn (Tab. 1). W celu określenia zależności pomiędzy nasileniem badanej patologii (wyrażonym przez indeks desaturacji – ODI) a wartościami pomiarów somatycznych zastosowano analizę dyskryminacyjną.

W wyniku przeprowadzonych badań otrzymano zbiór zmiennych somatometrycznych pozwalających na wyznaczenie funkcji klasyfikacyjnych. Na podstawie wyznaczonych funkcji możliwe jest zakwalifikowanie badanych do grupy osób zdrowych lub do grupy zwiększonego ryzyka zachorowania (Tab. 2, Rys. 1). Poprawność klasyfikacji do grupy osób zdrowych oszacowano na 81,4% a do grupy osób chorych na 91,3% (Tab. 3). Wybrane pomiary somatyczne (zmienne dyskryminujące) potwierdzają wpływ otyłości na nasilenie badanej patologii. Otrzymane funkcje klasyfikacyjne mogą być wykorzystywane we wstępnej klasyfikacji badanych osób do dalszego postępowania medycznego.