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Original Research Article

Somatotype and Musculoskeletal Disorders Prevalence among Heavy Load Carriers

Mbang Bian William[1,2], Assomo Ndemba Peguy Brice[2,3], Guessogo Wiliam Richard[1,2], Mekoulou Ndongo Jerson[2], Ebal Minye Edmond[1], Mbouh Samuel[1], Mandengue Samuel Honoré[2,4], Temfemo Abdou[2,4,5,*]

[1]National Institute of Youth and Sports, Yaounde, Cameroon
[2]Exercise and Sport Physiology Unit, Faculty of Science, University of Douala, Douala, Cameroon
[3]Department of Human physiology, Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Yaounde, Cameroon
[4]Department of Biological Sciences, Faculty of Medicine and Pharmaceutical Sciences, University of Douala, Douala, Cameroon
[5]Laboratoire EA3300 – APERE: Adaptations Physiologiques à l'Exercice et Réadaptations à l'Effort, Faculté des Sciences du Sport, Université de Picardie Jules Verne, Amiens, Cedex, France

***Corresponding author:** Temfemo Abdou
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Abstract

The purpose of the present study was to determine the somatotype profile and to assess the prevalence of musculoskeletal disorders (MSDs) according to the somatotype among heavy load carriers. This cross-sectional study was performed on 301 carriers. The method used for determining the somatotype according to Heath and Carter was characterised by calculating the individual components: endomorphic, mesomorphic, ectomorphic. Prevalence of the MSDs was investigated with a Nordic Questionnaire. The neck, shoulders, upper back, lower back, hips/thigh were the body parts in which more than 50% carriers reported MSDs. The MSDs at the level of the wrists/hands was significantly (P <0.001) more frequent in the mesomorphic profile (53.8%) compare to the profiles of endomorphic (10.9%) or ectomorphic (40.9%). In contrast, the frequency of MSDs at the ankles/feet was reported to be significantly higher in the ectomorphic profile (40.0%). This study showed the endomorphic profile to be the most representative among heavy load carriers followed by the ectomorphic profile. If the MSDs at wrists/hands and the ankles/feet were more in mesomorphic and ectomorphic profiles than in endomorph group, the rate of MSDs at the neck, shoulders, upper and lower back, hips/thighs were the same in the three groups.

Keywords: Somatotype, musculoskeletal disorders, load carriers.

INTRODUCTION

When performing the various daily tasks, man generally solicits the musculoskeletal system and in particular the spine which is the central framework of his body movements. This complex presents, because of its structure, the characteristic of a sagittal balance which is conferred thanks to its curvatures. Any modification beyond or below normal physiological values is considered pathological and could lead to musculoskeletal injury [1].

The carriage of heavy loads is primarily known to be a risk factor in a nearest or far future for spinal trauma. This link is more marked as handling is associated to other important physical demands such as unbalanced postures, vertical displacement, etc. as it is often the case [2]. These could be the source of acute or chronic injuries. Whatever the type of activity and the degree of risk, however minimal, it should not be neglected [3]. In the execution of an activity, certain pathologies due to musculoskeletal disorders (MSDs) can appear following the modification of the sagittal balance [4, 5]. These disorders are considered as a set of painful lesions that affect the components of the spine [6].

In a good number of developing countries like Cameroon where the usage of handling aids is not widely observed, loading or unloading trucks of goods is done on the head. This technic of carriage is commonly practiced in some African countries [7], is a way of carrying being an integral part of the social and economic lifestyle in Africa South of the Sahara [8], and would have emerged from the social practices of reference that characterized the life of people at given times. In this case, the body of the handler is the main equipment used and, the physical strength one of the assets that the activity requires.

Numerous studies have shown that carrying heavy loads during daily presents a high risk of MSDs on some body parts [9, 10]. Carrying loads on the head can cause MSDs and can be detrimental to the spinal health of the carrier, because it imposes a considerable effort on the axial skeleton [11, 12]. The findings of Jäger *et al*., [13] revealed an exacerbated degenerative change in the cervical spine following an axial loading on the head. Furthermore, even carrying water on the head for domestic use by women and children in South Africa has shown a prevalence of 69% for spine pain and 38% for those of the back [14].

In practice, the adoption of different static postures for certain body segments characterizes the activity of the handlers and is most of the time detrimental to their physical integrity. Handlers multiply certain gestures that frequency and volume could cause MSDs. According to Pal *et al.*, [15], poor work posture is one of the major causes of work-related pain and it is important to point out that repeated actions following the execution of a task impose a cumulative workload that could be considered as the cause of work muscle pain and weakness [16]. In addition to the great repetitiveness of the actions performed by the handlers, they work the whole day and this extended work would also lead to MSDs [17]. It has been shown that the percentage and degree of damaged tissue depends on the amount of force deployed, the number of times a gesture is repeated and the duration [18]. With all the above-mentioned sources of MSDs, we can notice that all of them are related to movement and posture. As it can be noticed, many studies showed a relationship between MSDs and some body parts but not with somatotype. Defined by Singh [19] as a unique method for the classification of human physique which was first invented by Sheldon et al. [20] and later modified by Heath and Carter [21], somatotyping gives informations reflecting an overall outlook of the body and conveys a meaning of the totality of morphological features of the human body. The somatotype is defined as the quantification of the present shape and composition of the human body. It is expressed in a three-number rating representing endomorph, mesomorph and ectomorph components. The somatotype as always been used in the domain of sport and for researcher, is an important element for the determination of performance. It is not possible to reach a certain level of performance without suitable physical properties related to the sport practiced [22]. Body structure is one of the factors influencing performance [23]. Considering carrying heavy load as a physical activity, it can expose the handlers to any MSDs as the body is concerned. We think that the practice of this activity requires a specific somatotype.

Therefore, the present study aimed to establish the somatotype profile of heavy load carriers in Cameroon, and to determine the distribution of MSDs with respect to somatotype profile.

MATERIALS AND METHODS

This study was approved by the ethics committee of the National Institute of Youth and Sports in Yaounde. All participants were informed about the aim of the study and about the possibility of immediate withdrawal from the study without giving a cause. All handlers agreed to conditions that were presented in written form; and the study was performed in accordance with the Helsinki declaration as amended in Fortaleza, in October 2013.

Study Design

The current study was a cross sectional research among some heavy loads carriers.

Study Population and Sample

Participants were 301 male handlers offloading bags of cement and cartons of ties and other heavy goods from trucks to warehouses, bags of flows and crops by carrying them on their heads. Where excluded from the study, handlers absent during the data collection. The number of participants recruited was determined according to the Lorentz formula, with the prevalence of musculoskeletal disorders of 50%, for a consistency threshold of 1.96 and a margin error of 5%. The minimum sample size of this study could be 213 subjects.

Measurements

Data were collected using the section 2 of the Nordic Questionnaire for MSDs assessing nine anatomic sides (neck, shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees and ankles/feet). Handlers were questioned on their state health (presence of ache, pain, discomfort, trouble) in the last 12 months.

The weight of each participant was measured using a Tanita impedance scale (Tokyo, Japan) and the body height by a wall scale graduated in millimeters. A digital body fat was used to measure the skinfolds of triceps, subscapular, supraspinal, and calf. A 150 cm length tape allowed to determine the circumferences of flexed biceps and calf and a German made 0-150 mm digital caliper permitted to evaluate the width of elbow and knee joint.

Somatotype was determined using equations derived from the rating form:

Endomorphy = 0.7182 + 0.1451 (X) - 0.00068 (X^2) + 0.0000014 (X^3). Where X = (sum of triceps, subscapular and supraspinale skinfolds) multiplied by (170.18/height in cm). This is called height-corrected endomorph and is the preferred method for calculating endomorph. Mesomorphy = 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth+ 0.161 x corrected calf girth – height 0.131 + 4.5.

Ectomorphy (EC) is determined according to the height-weight ratio (HWR).

If HWR is:

- Greater than or equal to 40.75: EC = 0.732(HWR) – 28.58
- Between 40.75-38.25: EC = 0.463(HWR) – 17.63
- Smaller than or equal to 38,25: EC = 0.1

Where HWR = Body height/weight$^{1/3}$

Statistical Analysis

Statistical analysis was performed using SPSS version 25.0 (SPSS Inc., Chicago, IL, USA) Quantitative variables were expressed as means ± standard deviation (SD) and qualitative variables in percentage (%). Independence and goodness-of-fit tests of chi-square were used to compare proportions of MSDs between somatotypes; Significance was set at P-value less than 0.05.

RESULTS

Heavy load carriers had 31.1±5.7 years of age, 1.72 ± 0.7 m of height, and 69.32 ± 9.21 kg of body weight, and 6.7±3.0 years of practice. The calculated body mass index (BMI) was 23.3 ± 3.7 kg/m^2.

The number of heavy load carriers in each somatotype profile was 183 (60.8%) for endomorphic, 13 (4.3%) for mesomorphic, and 105 (34.9%) for ectomorphic profiles.

The MSDs of wrists/hands was significantly (p<0.001) and more frequent in the mesomorphic profile (53.8%) compare to the endomorphic profile (10.9%) and ectomorphic profile (40.9%). The neck, shoulders, upper and lower back, hips/thighs were body parts mostly affected by the MSDs in endomorphy and mesomorphy profiles (p<0.001). These parts of body were also the most injured body part with more than 50% prevalence for all the three categories of somatotype (Table-1).

Table-1: twelve months occurrence of MSDs by body site according to somatotype

	Somatotype							
	Endomorphy		**Mesomorphy**			**Ectomorphy**		
Body parts	**N**	**%**	**n**	**%**		**n**	**%**	**P-value**
Neck	134	73.2	12	92.3		78	74.3	0.890
Shoulders	127	69.4	7	53.8		65	61.9	0.282
Elbows	37	20.2	4	30.8		18	17.1	0.595
Wrists / hands	20	10.9	7	53.8		43	40.9	0.001*
Upper back	106	47.9	8	61.5		72	68.6	0.738
Lower back	157	85.8	10	76.9		85	80.9	0.459
Hips / thighs	152	83.1	11	84.6		80	76.2	0.488
Knee	76	41.5	9	69.2		44	41.9	0.530
Ankle / feet	58	31.7	5	38.5		42	40.0	0.001*
P-value¶	0.001*		0.001*			0.058		

DISCUSSION

The principal result of this study was the great percentage (60.8%) of endomorphic profile heavy load carriers compared to those of ectomorphic and mesomorphic profiles heavy load carriers (34.9 and 4.3 %, respectively). This result agreed that of Toth *et al.*, [24]. These authors observed in 13 bodybuilders, 11 with endomorphic somatotype profile. Heavy load carriage is a daily activity that has exigencies like sport by the fact that carriers have to work in repeated exercises for long periods. This kind of intense, repeated, long-term exercise requires a source of body energy rich in carbohydrates and lipids. The endomorphic heavy load profile of the handlers could then be justified by the presence of adipose tissue necessary to provide energy of the lipid sector important for the aerobic metabolism.

While we expected to have a greater number of mesomorphic heavy load carriers compared to ectomorphic ones, the result of the study showed the opposite. This result is in agreement with that of Gutnik *et al.*, [25], who found some highly trained kayakers with lean bodies instead of those with mesomorphic profile. The also not negligible presence of the ectomorphic heavy load carriers could be justified by the constitution of their thin muscles which could contain a lot of slow muscle fibers that can resist during repeated long-term tasks.

One could think of a link between the BMI and the somatotype, yet the two parameters bring out the notion of fat levels in the body. Anthropometric somatotyping is one of the methods that describe the shape and composition of the body. It is well used in sport in relation to performance. As it is known that the practice of sports activities leads to contracting certain MSDs, it may be thought that being exposed to a type of MSD may be due to the belonging to a somatotype component. In the present study, the BMI were significantly different between the three somatotypes (26.3±3.4; 24.4±2.5; and 19.6±3.6 kg/m^2; respectively for endomorphic, mesomorphic, and ectomorphic heavy load carriers) although Jeremy's [26] research on BMI did not showed it as an indirect indicator of somatotype.

Subjects of the present study showed the most affected body parts in the last 12 months prior to the evaluation. The neck, shoulders, upper back, lower back, and hips/thighs, had prevalence greater than 50% for the three categories of somatotype (Table-1). The results showed the MSDs of the wrists/hands to be the more significantly frequent ($p<0.001$) in the mesomorphic (53.8%) compared to the endomorphic (10.9%) and ectomorphic (40.9%) heavy load carriers carriers. These frequent MSDs of wrists/hands could be explained by constantly stressed during the pulling of loads by these parts of the body. In contrast, the frequency of MSDs at the ankles/feet was significantly higher in ectomorphic heavy load carriers (40.0%). It is known that the ectomorphic heavy load carriers describes the thinness of the body, as well as the existence of a frequent MSDs in ankles/feet in the ectomorphic heavy load carriers, which are explained not only by the thinness, but also by the linearity of the relative length of the body segments. In this case, this injury mainly related to the length of the foot is also aggravated by the heavy load.

The high prevalence of injury in the lower back and hips/thighs area was similar to the value observed by Zaletel *et al.*, [27] on injuries among pre-professional dancers. These similar prevalences are related to torsion-detorsion, flexion-extension movements at the trunk-pelvis exerted during the dance or the heavy load charge-discharge. In the three categories of somatotype, if the neck, shoulders, upper and lower back, hips/thighs were the parts of the body mostly affected by MSDs, this result could be due to the transport of an average load of 50 kg on the head. When carrying heavy loads, the upper limbs are first solicited (catch-lift-put on the head). This may explain the MSDs of the wrists and shoulders. Then, carrying on the head could explain the MSDs of the neck, back, hips and lower limbs. These kinds of MSDs are reported by Heydar *et al.*, [28] on the relationship between posture and somatotype regarding the postural variables of the Iranian National Dragon Boat Team.

The significant exposure of a somatotype profile to MSDs in an activity could be related to the large percentage of the participation of handlers of this somatotype in the activity. Thus, Heydar *et al.*, [28] reported greater MSDs in mesomorphic and ectomorphic athletes. Unlike the results of Heydar *et al.*, [28] on mesomorphic and ectomorphic athetes, our results are consistent with those of Afshin *et al.*, [29] whose activity exerted by the athletes abounded of endomorphic subjects as in this study. The study of Afshin *et al.*, [29] showed the endomorphic subjects more exposed with regard to the risk of injury during sports activities with jump. Carrying heavy loads could be considered as high-intensity sports with high-volume, and intermittent physical activity, hence the high prevalence of endomorphic carriers in this study. This could also explain the greater prevalence of MSDs in the endomorphic heavy load carriers.

The high prevalence of knee MSDs in basketball players has allowed many authors [30-32] to consider these athletes as endomorphic subjects (yet mesomorphic subjects). According to Quinette *et al.*, [33], the knee of the basketball players are the part of the body that suffers the most from MSDs due to the different biomechanical movements of the jump and the landing. This important weight is assimilated by these authors to the overweight observed in endomorphic subjects despite differences in shape and body fat levels. In this study, knee MSDs were dropping in endomorphic compared to mesomorphic heavy load carriers.

Conclusion

This study showed that heavy load carriers presented endomorph somatotype profile. Mesomorph and the ectomorph somatotype are related to MSDs respectively at the level of the wrists/hands and the ankles/feet. However, in the three categories of somatotype, neck, shoulders, upper and lower back, hips/thighs were the body parts mostly affected by MSDs.

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Conflicts of Interest

The authors declare no conflict of interest.

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