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Physical condition and physical fitness of the candidates for polar expeditions

ABSTRACT: Results from anthropometric measurements and examinations of physical fitness of the candidates for the Polish Polar Expeditions from 1976 till 1980 are presented. The authors suggest the necessity of introducing fixed norms of physical fitness in medical qualification of the candidates for polar expeditions.

KEY WORDS: medical examination, polar expeditions, physical fitness

1. Introduction

Beginning with the First Polar Expedition of the Polish Academy of Sciences the state of health of the participants was determined from the viewpoint of their capability to work under Arctic and sub-Antarctic conditions. In the qualifying multi-specialistic medical examinations the criteria accepted in other countries were used according to SCAR recommendations. Medical examinations were supplemented with a comprehensive anthropological evaluation of physical condition and an efficiency test, making possible to determine the level of physical fitness and the course of the blood circulatory system adaptation to the strain of exertion.

The aim of this study is to present the general characteristic of physical condition of the candidates for Polar expeditions and the analysis of their physical fitness.

2. Material and methods

The number of candidates for Polar expeditions examined during the period of 1976—1980 included 394 males, from 20 to 60 years old, and 25 females. The data from the medical examination of females were not analysed, owing to a small number of the candidates in this

group and the lack of the norms of physical efficiency for the female population of Poland.

Anthropometric examination included the measurements of height, weight, chest circumference and the thickness of fatty folds in the diagnosed places. From the obtained data Rohrer Index, Quetelet Index, the degree of deposition of fat, using indirect caliper method, and lean body mass (LBM) were calculated. Effectiveness of respiratory system was determined on the basis of the parameters of forced ventilation, measured with a Draeger spirotrone. Moreover, Spehl Index and Amar Index, characterizing normalized lung capacity were calculated (after deduction of the height and body weight factors).

In the examination of physical fitness energy tests were made by means of a Schönander ELEMA cycloergometer, the applied loads depended on the body weight and actual exertion possibilities of the examined candidate. The maximal oxygen uptake — $\dot{V}_{02}$max, calculated indirectly from the Astrand and Ryhming nomogram (1954) on the basis of the average rate of contractions of the heart in the last two minutes of work, was used as an indicator of physical fitness. The calculated $\dot{V}_{02}$max value reduced to one kilogram of body weight was compared with the physical fitness norms for airplane pilots, worked up in the Military Institute of Aviation Medicine.

3. Results

As regards anthropologic characteristics the examined candidates were, in principle, within the limits of the average values for healthy males in Polish population (Table I). The only significant differences

Table I

Anthropometric measurements of the candidates for Polish Polar Expeditions

Parameters	Unit	$\bar{x}\pm$S.D.	Range
Age	yrs	37.5±8.6	20—60
Height	cm	174.3±7.7	152—192
Weight	kg	74.9±8.3	50—104
Quetelet Index	—	430.2±53.8	307.8—590.9
Rohrer Index	—	1.42±0.15	1.02—1.94
Body Fat	%	13.5±3.3	6.0—19.5
Lean Body Mass	kg	64.4±7.2	47.6—83.9
Chest Circumference (xi)	cm	91.7±6.3	80—108
Spehl Index	—	2188±500	1478—3359
Amar Index	—	67.9±12.2	49.6—111.1
FVC	l	5.09±0.84	2.8—7.5
FEV_1	l	4.2±0.8	2.6—6.3
FEV_1/FVC	%	82.3±11.8	59—100
FEV_3	l	4.9±0.8	2.8—7.5
FEV_3/FVC	%	97.6±3.5	85—100

were found in the measurements of height ($\bar{x}$ = 174.3 cm) as compared with the average value ($\bar{x}$ = 169.5 cm) for Polish population (Batogowska and Słowikowski 1974).

In the examination of the state of nourishment body weight was evaluated according to Węsław nomograms (1965). The determined prercentage (17%) of the total number of the examined candidates with overweight above 15% of the proper normal body weight did not deviate from the data for male population of Poland (Tatoń 1975) or the data for other professional groups of males (Łysoń-Wojciechowska 1975).

The energy exertion test was completed by 358 males out of the total number of 394 candidates under examination. In 36 cases (9.14%) the examination was interrupted on account of incorrect adaptation to the exertion strain mostly hypertonic reaction or extrasystoles. Moreover, in 8 cases the maximal oxygen uptake value was not determined owing to the overstepping of the limits of the rate of heart contractions established for indirect method of examination.

The results from examination of physical fitness of 350 males were analysed (Table II).

Table II

Maximal oxygen uptake ($V_{O_2}max$)

Age	n	$l \cdot min^{-1}$	$ml \cdot kg^{-1} \cdot min^{-1}$
		$\bar{x} \pm SD$	$\bar{x} \pm SD$
20—29	76	2.56±0.59	35.62±8.79
30—39	144	2.38±0.51	32.02±7.13
40—49	110	2.06±0.42	28.19±5.81
50—60	20	1.96±0.44	26.05±4.15

Due to the lack of norms for Polish population the evaluation of physical fitness was determined after the norms used in medical examination of flying personnel. This seems reasonable since a similar level of the capacity for work is required of the participants in polar expeditions (Fig. 1).

Nearly a half of the candidates (45.4%) showed a very low level of physical fitness. The mean $V_{O_2}max$ values converted into a kilogram of body weight were for the examined candidates lower by several percent than for e.g. a group of chemical factory workers (Szwarc and Jopkiewicz 1975).

Hitherto a very low level of physical fitness was not treated by the qualifying medical board as on absolute contraindication in determination of the capability of working under polar conditions. However, in the face of the evidence of an alarmingly level of physical fitness of the examined candidates it seems necessary to introduce the requirement of a minimal level of the V_{O_2} max values, as one of the conditions for admission to the participation in polar expeditions. The value of the maximal oxygen uptake reflects capacity for work under aerobic conditions. The V_{O_2} max values keep within the limits the range of strains

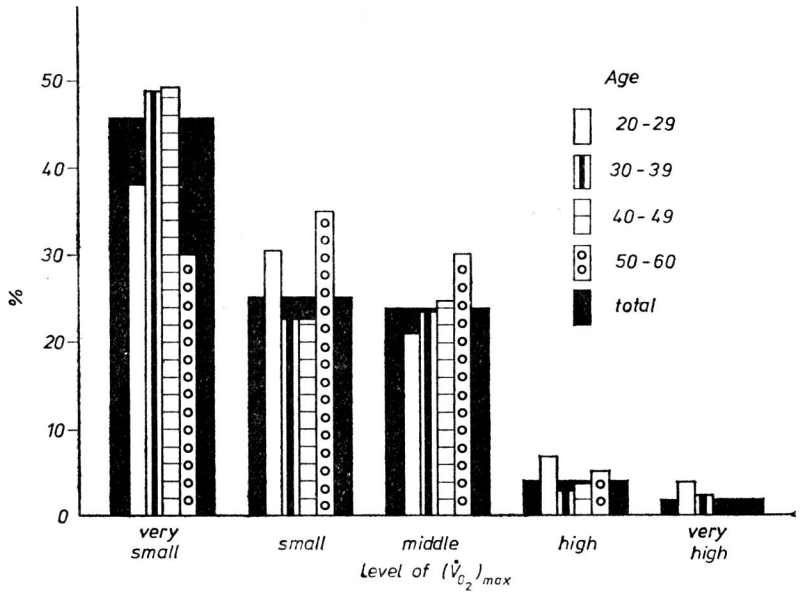

Fig. 1. Maximal oxygen uptake in relation to standardized norms of V_{O_2} max

that man is able to endure during a long time without a serious disturbance of homeostasis, promptly increasing lassitude and overstrain of the organic system (K o z ł o w s k i et al. 1968). People with a low exertion power are additionally handicapped as regards their capacity for work by the lowering of the level of strains, at which anaerobic processes increase in the exertion metabolism (K o z ł o w s k i 1973). This is a serious limitation of the already low potentiality for exertion.

Practical experience of the physicians participating in the first three polar expeditions confirms by evidence the necessity of introducing definite requirements as regards capacity for exertion, at the selection of the candidates for further expeditions.

As the main causes of accidents and connected with them injuries and traumas the following were mentioned among others (K u n t z e, D u b i c k i and D o m a s z u k 1980):

— overtaxing with strenuous physical labour of unlimited duration,
— unpreparedness of scientific staff for exhausting physical work,
— injuries connected with taking part in winter sports, recreational activities, etc.

More exacting requirements of a higher level of physical fitness may contribute to a decrease of the number of accidents and injuries, causing serious problems as well with respect to the safety of the participants in the expeditions, as the possibilities of realization of the proposed research program.

The course of the polar expeditions, until this time, allows to determine the level of the strains the participants are exposed to. The most important of them are:

— exceptionally unfavourable climatic conditions,
— physical work in a dangerous terrain,
— intermittently, high intensity of physical work.

It should be emphasized that participants in polar expeditions must be prepared for a limitation of the possibility of bodily exertion already at the beginning of the expedition — on board of a ship at sea. This is connected with a decrease of natural locomotive activity and putting on flesh, which occurs quite often. The lowering of the level of physical fitness was also observed during the stay in Antarctica (Halter, and Kowalski — unpubl. data).

The comparison of the tasks of the participants in polar expeditions with the level of physical fitness determined in medical examinations of the candidates indicates the necessity of introduction into the qualifying examinations of the requirement of an established minimal level of physical fitness to be used as a basic criterion of the capacity for work under polar conditions.

4. Summary

Measurements and evaluation of physical fitness and physical development of the candidates for polar expeditions were carried out in 1976—1980. The measurements were made during multi-specialistic qualifying examinations. In anthropological examinations no significant differences were found as compared with the average values for male population of Poland (Table I). The general level of physical fitness of the examined candidates was estimated as pretty low. Nearly a half of the candidates (45.4%) showed a very low level of physical fitness (Fig. 1).

It is suggested, therefore, that a minimum of the required level of physical fitness should be introduced into the qualifying medical examinations, to be used as a criterion of the capacity for work under polar conditions.

5. Реэюме

В годы 1976—1980 проволилась оценка физического развития и работоспособности кандидатов на польские полярные экспедиции. Названные параметры определялись в ходе многосторонних квалификационных исследований. В результате антропологических исследований кандидатов не удалось установить существенных разниц по сравнению со средними показателями мужчин польской популяции (таблица I). Общий уровень физической работоспособности кандидатов оценивался как низкий, при чем почти половина (45,4%) характеризовалась очень низким значением этого параметра (рис. 1).

Подчеркивается необходимость принять в квалификационных исследованиях определенный уровень работоспособности и считать его критерием работоспособности в полярных условиях.

6. Streszczenie

Dokonano oceny wydolności fizycznej i rozwoju fizycznego kandydatów do polskich wypraw polarnych w latach 1976—1980. Pomiary wymienionych parametrów wykonywano podczas wielospecjalistycznych badań kwalifikacyjnych. W badaniach antropologicznych nie stwierdzono istotnych różnic w porównaniu z prze-

ciętnymi wartościami dla mężczyzn populacji polskiej (tabela I). Ogólny poziom wydolności fizycznej badanych kandydatów oceniono jako niski, przy czym prawie połowa badanych (45.4%) charakteryzowała się bardzo małą wydolnością fizyczną (rys. 1).

Sugeruje się potrzebę wprowadzenia w badaniach kwalifikacyjnych minimalnego wymaganego poziomu wydolności fizycznej i traktowania go jako kryterium zdolności do pracy w warunkach polarnych.

7. References

1. Astrand P. O., Ryhming I. 1954 — A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work J. Appl. Physiol. 7: 218—221.
2. Batogowska B., Słowikowski J. 1974 — Atlas antropologiczny dorosłej ludności Polski dla potrzeb projektowania — Inst. Wzorn. Przem. Warszawa.
3. Kozłowski S., Nowakowska A., Kirschner H., Obuchowicz-Łożyńska Z. 1968 — Ocena pośredniego wyliczania wysokości pułapu tlenowego człowieka (nomogram Astrand-Ryhming) jako metody pomiaru zdolności do pracy w warunkach aerobowych — Wych. Fiz. i Sport 2: 3—17.
4. Kozłowski S. 1973 — Fizjologiczne podłoże tolerancji wysiłkowej człowieka — Pol. Arch. Med. Wewn. 1: 1—7.
5. Kuntze A., Dubicki T., Domaszuk J. 1980 — Analiza stanu zdrowia personelu Polskiej Stacji Antarktycznej w latach 1976—1979 — Med. Lotn. 69: 48—52.
6. Łysoń-Wojciechowska G. 1975 — Normy otłuszczenia dla personelu latającego w oparciu o pomiary podskórnej tkanki tłuszczowej metodą cyrklową i ich zastosowanie w orzecznictwie lotniczo-lekarskim — Med. Lot. 49: 9—18.
7. Szwarc H., Jopkiewicz A. 1975 — Zmiany wydolności fizycznej mężczyzn wraz z wiekiem — Wych. Fiz. i Sport 1: 13.
8. Tatoń J. 1975 — Otyłość — PZWL, Warszawa.
9. Węsław T. 1965 — Nomogramy dla obliczania wagi należnej ludzi dorosłych — Lek. Wojsk. 11: 991—994.

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