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**INDUSTRIAL  
FATIGUE RESEARCH BOARD.**

**REPORT No. 44.**

**The Physique of Women in  
Industry.**

**A CONTRIBUTION TOWARDS THE DETER-  
MINATION OF THE OPTIMUM LOAD**

BY

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## PREFACE.

The subject of weight-lifting and carrying by women is one that has already engaged the attention of the Board, who initiated an investigation under the supervision of Professor E. P. Cathcart, F.R.S., and published the results in 1925.\* This investigation, which dealt primarily with the relative advantages of different methods of weight-carrying, showed that when judged by the physiological cost (the oxygen consumed per minute), these methods, irrespective of the actual weight carried, could be arranged roughly in order of merit, depending mainly on the degree of displacement of the body necessary to bring the centre of gravity over the feet, but also in some degree on other factors, such as the amounts of chest-fixation, muscular tension, local strain, and interference with the normal gait.

Suggestive as these results were, however, they did not throw—and were indeed not designed to throw—light on the equally important question, the maximum weight of load that can be carried without injury or discomfort, beyond showing that with some modes of carriage, loads above a certain weight caused an abrupt and large increase in the cost, owing to some factor involving strain or discomfort.

A request that the investigation should be continued so as to include this second point has since been made to the Medical Research Council by the Home Office. It was pointed out that the lifting or carrying of weights by women and girls has long been regarded as a matter requiring regulation, but that while it has been possible to insert provisions on the subject in codes of regulations made for dangerous or unhealthy industries, there has hitherto been no general or specific provision in the Factory Acts in regard to it. A proposal to rectify this omission appeared in the Factories (No. 2) Bill, 1926, Clause 47, which ran as follows :—

- “(1) A woman or young person shall not lift, carry or move any load so heavy as to be likely to cause injury to such woman or young person.
- (2) The Secretary of State may make special Orders prescribing the maximum weight of the load which may be lifted, carried or moved by women or young persons of any age ; and any such Orders may relate to women or young persons generally or to women and young persons employed in any class or description of factories, or when engaged in any process.”

In these circumstances, the Home Office requested that the actual load that can be lifted or carried by women and young workers under industrial conditions without injury or discomfort should be the subject of scientific investigation, pointing out that, in the event of the new powers contemplated in the Bill being approved by Parliament, the results of such an inquiry would afford them valuable guidance.

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\* BEDALE, E. M. (1925) : “ The Effects of Posture and Rest in Muscular Work.” *Report No. 35.*

The Board were again fortunate in obtaining the consent of Professor Cathcart to direct the investigation. It was obvious from the beginning that if trustworthy conclusions were to be drawn, the problem would have to be attacked from several different aspects, and the data collected over a very wide field. Accordingly, three simultaneous lines of inquiry were designed. In the first place, an extensive survey was made in order to collect anthropometric data of about 4,000 women engaged in different occupations and of suitable controls. The following measurements were taken for each woman :—

- (a) Weight.
- (b) Height.
- (c) Length of arm.
- (d) Distance of finger-tips from ground (standing).
- (e) Three physical strength tests, two of them involving the use of muscles ordinarily employed in industrial practice and one of them the use of muscles rarely employed.

The results of this part of the investigation are of special value in showing the variations in these attributes amongst women, and in indicating the extent to which the stronger women tend to gravitate towards the more strenuous occupations. Further, they throw some light on the way in which the exercise of strength depends on mental alertness as well as a muscular capacity. In the determination of the physiologically economic load, it was found that the best rough physical indication of strength among comparable individuals is body weight, and the practical conclusion is reached that variations in the strength of individuals can be met best by assessing the economic load to be carried and lifted as a definite fraction of the body weight.

In the second part of the investigation, the earlier researches into methods of weight carrying, to which reference has already been made, were repeated and amplified by study of variations in the disposition of the load. The previous results are in all essentials confirmed, and the tentative conclusion reached that 50 lb. for "conveniently disposed" loads and 40 lb. for "inconveniently disposed" loads is about the maximum physiologically economic load for women continually engaged in carrying.

Finally, in order to obtain a picture of existing practice a series of about 550 observations of the loads actually carried or lifted in different industries was made, the weight of each person being also taken so as to admit of a comparison between body-weight and load. For the purpose of studying the demands made on different classes of workers, the subjects tested were grouped according to whether they were young persons aged 14-16, young persons aged 16-18, or women over 18. It was found that the industries varied in order of sequence for each of these groups in respect not only of the weight of individual loads and the total load

moved *per diem*, but also of the body weights of the workers and of the ratio of load to body weight. An important distinction, however, is drawn between industries where the weight of the load is definitely fixed, and those where the load can be selected to suit the personal convenience of the operative. The conclusions reached are that in regard to fixed loads, the weights in present industrial practice are on the whole well within the capacity of women and adolescents, whilst in occupations where choice of the weight is available to the operative, women are usually self-protective, but young persons of both sexes, particularly males, are sometimes apt to attempt to lift and carry a load heavier than that for which they are adapted. The opinion is expressed that the weight of the individual load should not exceed 40 per cent. of the body weight for continuous, and 50 per cent. of the body weight for intermittent or occasional carrying.

The special precautions to be observed in co-ordinating the results of these different lines of investigation scarcely need emphasising. Account for instance had to be taken of the wide range in strength and other physical attributes amongst women, of the effect of age, and particularly of the fact that the heavier and more strenuous occupations tend to attract the stronger women, so that any standard based on the requirements of the average industrial woman would be inapplicable to special occupations for which women of exceptional physique are recruited.

The main conclusions arrived at may be divided into two categories, the first relating to women (as represented by the average of those examined and exclusive, therefore, of those exposed to selective influences of the kind referred to), the second to adolescent girls. The authors state that according to the laboratory researches on physiological cost of carrying, the most economic load appears to be about 35 per cent. of the body weight, though the actual percentage depends to a large extent on the mode of carriage. On the other hand, the subjects in these experiments were purposely selected as untrained in any one method, and accordingly to suggest a limitation at this figure would appear to be unnecessarily stringent.

They point out that if the suggestion made in Part III—that the maximum loads should be 40 per cent. of the body weight for continuous and 50 per cent. for intermittent carrying—were adopted, these would correspond to 45 and 55 lb. according to the average physical data obtained in Part I. The final conclusion reached is that while the data, translated into actual weight, indicate that a load of about 45 lb. would appear to be the optimum for continuous carriage, the body of the average healthy woman worker would not be in any way strained by a load not exceeding 50 lb., with a possible extension of 20 per cent. when the load is compact and easily handled so that it does not interfere materially with the gait and balance of the bearer.

In the case of adolescents, another factor must be taken into account, namely the plastic condition of the body and the risk of malformation and distortion. The authors think, therefore, that it would be unsafe to adopt the above percentages of body weight as a hard and fast standard, even though the adolescent would probably be physically capable of handling a load so assessed, and they suggest as an alternative a limit of 25 to 30 lb. for female young persons aged 14 to 16, and a limit of 40 lb. for female young persons aged 16 to 18.

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The Board desire to record their indebtedness to the members of the Committee on Physiology of Muscular Work, under whose general supervision the investigation was conducted, and particularly to Professor E. P. Cathcart, F.R.S., for his personal direction of the work.

*November, 1927.*

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# THE PHYSIQUE OF WOMEN IN INDUSTRY

(A Contribution towards the Determination of the Optimum Load.)

BY

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