Evaluation of Human Energy at Drilling Workstation – A Methodology

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***ABSTRACT*- The energy that human body requires to maintain its organic and vital functions is obtained by the oxidation of macronutrients from foods. The energy expenditure determination is important to adjust the individuals' nutritional offer, and must consider the demand of energy for physical activity and specific health conditions. This review describes the energy expenditure components as well as discusses several methods for energy expenditure estimation, emphasizing their advantages and limitations. The process of axle drilling at Sevagram MIDC at Wardha is a man-machine system; the mathematical model will be useful in selecting the input variables so as to reduce human energy consumption and to improve the productivity. The Tractor axle drilling process which is considered for study is a complex phenomenon & hence the estimation of energy expenditure while performing axle drilling is main objective of this paper.**

KEYWORDS: **Consumption, Energy expenditure, Man-Machine system, Nutrition, Tractor axle drilling.**

I. INTRODUCTION

Energy needs of a research subject are based on how much energy is expended in a given situation. A study setting could vary from a free-living situation to a confined chamber room or calorimeter. Hence, estimating energy expenditure with the desired level of accuracy is crucial to metabolic research.These include studies that involve overfeeding/underfeeding experiments, chamber stays, doubly-labeled water measurements etc. Research studies that have limited resources and can compromise on accuracy should use the Mifflin predictive equation with a suitable activity factor to estimate TEE for subjects.The Tractor axle drillingprocessat Asha Industries Pvt. Ltdis considered for study is a complex phenomenon & hence the estimation of energy expenditure while performing axle drilling is main objective of this paper.

II. TRACTOR AXLE DRILLING PROCESS

Enterprise selected for study is a medium scale industry in Sevagram MIDC at Wardha in Maharashtra. The industry is involved in axle drilling for various types of tractors. Drilling process of axle is targeted for Mahindra tractor as it is having the highest production rate as its requirement.

III. LITERATURE REVIEW

In this study we investigate human energy requirements in rural electrification with Jatropha oilLars Kare Grimsby (2012) et al,To evaluate the possible linkages between societal well-being and net energy availability Jessica G. Lambert (2014)et al,In addition, the most accurate equation for estimating the REE in the obese older subjects has been shown Michaela Noreik(2014) et.al, Genetic optimization algorithm muscle activation has been optimized in order to minimize metabolic energy consumption Franz Höchtl (2010) et al, Energy harvesting is an emerging technology that can power electronic devices using energy scavenged from the motion of the human body Hui Huang (2011) et al, The determination of energy expenditure is of major interest in training load and performance assessment Nikolai B. Nordsborga(2014) et al, This study utilized the Sensewear (SWA) armband and a diet journal to promote adolescents' EB knowledge and motivation Senlin Chen (2013) et.al, Man imagined, built and implemented a set of technical means whose operating principle is based on human renewable storing this energytechnical means can have miraculous effects related to human renewable energy storage Emilian M. Dobrescu (2012)et al, Workforce diversity means similarities and differences among employees in terms of age, cultural background, physical abilities and disabilities, race, religion, gender, and sexual orientation Ankita Saxena (2014) et al, The determination of energy expenditure, considering the physical activity level and health status, is very important to adjust the individuals' nutritional supplyA. C. PinheiroVolp (2005) et al.

IV. AIMS & OBJECTIVES

1. To evaluate the energy expenditure of human.
2. To know nutrition requirement and physical activity level of human.
3. To study the component of energy expenditure.
4. To formulate methods for determination of energy expenditure.
5. Assigning right work depending his/her energy expenditure and physical activity level.

V. MATERIALS & METHODS:

Several methods are available to measure one or all components of TEE. The main factors that help decide which method is suitable in a given research setting include:

1. Objective of assessment and level of precision - The purpose of estimating energy expenditure could be as basic as maintaining a subject in a weight-stable condition for a defined period of time or as complex as ensuring absolute energy balance during a 24-hour study in a calorimeter..
2. Resource availability and cost - This is an important factor that affects the decision, especially when studies have limited costs available for the nutrition component of the budget.
3. Subject burden - This generally is related to the objective of the research study. If diet plays an ancillary role, then the subject burden related to metabolic measurements is kept low. On the contrary, complex metabolic research, like chamber studies, pose greater burden on the subjects in order to yield the required data.

VI. METHODOLOGY

1. Evaluate energy expenditure of human body.
2. Measurement based on component of energy expenditure.
3. Methodology for determination of energy expenditure.
4. Food intake& energy expenditure questionnaires.

A. Evaluate energy expenditure of human body

The determination of energy expenditure, considering the physical activity level and health status, is very important to adjust the individuals' nutritional supply. Energy expenditure can be determined by using indirect calorimetry, bioelectrical impedance, doubly labeled water, predictive equations, among others.

B. Measurement based on components of total energy expenditure.

There are three main components of Total Energy Expenditure (TEE) in humans:

1) Basal Metabolic Rate (BMR) - Energy expended at complete rest in a post-absorptive state; accounts for approximately 60% of TEE in sedentary individuals.
2) Thermic Effect of Food (TEF) - Increase in energy expenditure associated with digestion, absorption, and storage of food and nutrients; accounts for approximately 10% of TEE.
3) Energy Expenditure of Activity- Further classified as Exercise-related Activity Thermo genesis associated with active sports or exercise and Non-Exercise Activity. Exercise-related Activity Thermo genesis may range from 0% of TEE in sedentary individuals to as high as 10% of TEE in active adults.

C. Available methods for determination of energy expenditure.

1) Predictive equations using anthropometric data -Out of the various equations validated, we recommend using the Mifflin equation to predict energy expenditure. This equation was found to be the most accurate predictor of energy expenditure in non-obese and obese individuals compared to direct calorimetry. The gender specific Mifflin equations are as follows:
   Males: REE = 10 x weight (kg) +6.25 x height (cm) – 5 x age (y) + 5
   Females: REE = 10 x weight (kg) + 6.25 x height (cm) – 5 x age (y) – 161
   TEE = REE x AF (study or population-specific activity factor).
   AF (activity factor) from Table 1.

2) Predictive equation using Fat-free Mass (FFM) - This method is commonly used in research studies that include measurement of body composition using the Dual Energy X-Ray Absorptiometry (DEXA) technique. The method is high in cost due to the DEXA scan involved and has precision comparable to BMR predictive equations based on anthropometric data.
   REE= {(FFM (kg) x 23.9) + 372}
   TEE= REE x AF (study or population-specific activity factor)
   AF(activity factor) from Table 1.

3) Resting Metabolic Rate Measurement - RMR measurement is very precise when compared to calorimeter results, and poses moderate subject burden and cost. Use of standard protocol and trained staff yields accurate results that can even be used to estimate energy needs for chamber studies.
   TEE = measured RMR (kcals) x AF (study or population-specific activity factor).
   AF (activity factor) from Table 1.

4) Room calorimetry - This is the most sophisticated form of the open-circuit system that involves placing the subject inside a room/chamber of known volume. The measurement can range from a few hours to several days. Energy expenditure measured through this method is considered the "gold standard" in the field of nutrition and metabolism.
TEE= 24-hour energy expenditure measurement in chamber room.

Activity Factors (AF)

Activity factors are also referred to as Physical Activity Levels (PALs) and have a wide range based on the population being studied. The following table categorizes PALs based on lifestyle:

TABLE I

ACTIVITY FACTOR BASED ON LEVEL OF ACTIVITY

Sr. no	Work condition and level of activity	PAL/AF
01	Seated work with no option of moving around and little or no strenuous leisure activity	1.4-1.5
02	Seated work with discretion and requirement to move around but little or no strenuous leisure activity	1.6-1.7
03	Standing work (e.g. housework, shop assistant)	1.8-1.9
04	Significant amounts of sport or strenuous leisure activity (30-60 min four to five times per week)	+0.3 (increment)
05	Strenuous work or highly active leisure	2.0-2.4

D. Energy expenditure questionnaires

The use of food intake questionnaires to estimate TEE has been widely discussed, mainly because people usually under-report their intake. Furthermore, the use of these methods would only be valid for individuals with stable weight which means in an energy balance the results showed that methods of dietary intake may provide an estimate of the calorie intake and indirectly from the TEE when subject is in an energy balance state.

VII. DISCUSSION

Round the year the human energy expenditure in the tractor axle drilling process will be estimated as per the methodology suggested above.

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