Time, Energy and Drudgery: Measuring the Hidden Costs of Daily Household Activities among Rural Women

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Abstract:

The present study was undertaken to assess the physiological workload and energy cost of routine household tasks among women of Haryana. A total of 483 women respondents were investigated across six categories of activities, with the largest participation in kitchen work (125), followed by cleaning (100), recreation (89), laundry (82), miscellaneous tasks (56), and baby care (31).Standardized methods were applied to record physical and physiological variables. Physical parameters included age, weight, height, and body mass index (BMI), while physiological measures comprised heart rate (HR), oxygen uptake, energy expenditure, basal metabolic rate (BMR), and physical activity ratio (PAR).Findings of the study revealed that observed group of women were having a mean age of 33.2 years, body weight of 55.6±24.6 kg, height of 157.5±6.9 cm, and BMI of 20.5±2.1 kg/m², representing a mesomorph body type. The average BMR was 1392.3±65.6 kcal/24 hrs.Among activities, the maximum time was devoted to cleaning utensils (53.52 min) and chapati making (46.96 min). Physiological stress was highest in dough making (102.36 bpm) and utensil cleaning (101.08 bpm). Wiping and washing floors showed the greatest exertion, reflected in elevated HR (106.28 and 100.12 bpm), oxygen uptake (0.42 and 0.32 l/min), energy expenditure (8.17 and 7.19 kcal/min), and high physical activity ratio (PAR) values (8.47 and 7.46). Carrying water (19.33 min) also imposed considerable stress, with heart rate 103 bpm and energy expenditure 7.65 kcal/min. Baby care activities, particularly holding (94.5 bpm) and breastfeeding (91.7 bpm), further contributed to elevated physiological load.Statistical analysis revealed significant associations of age, weight, height, BMI, and BMR with PAR, highlighting that physiological demands varied by women's physical characteristics. Rinsing clothes exhibited the highest PAR (8.74), followed by wiping (8.47) and hand washing clothes (8.34). The findings underscore the substantial physical workload rural women undertake in household activities, often comparable to moderate-to-heavy labor.

Key Words: *Energy cost, energy expenditure, heart rate, household activities, physical activity ratio and physiological stress.*

Conclusion:

1. Women were found to have average of2.85±0.64 children. The highest heart rate was noticed in holding a baby (94.5±11.57 beats/min) and breast-feeding activity (91.42±3.86 beats/min).
2. Findings explain that women were found to be having more physiological stress, as values of the physical activity ratio (8.47±0.71 and 7.46±0.68) reflect that these activities were high in exertion level.
3. Increasing weight in women was found to be significantly (p=0.0329) associated with an increasing physical activity ratio among women.
4. Study reflect that age (p=0.0019), weight (p=0.0001), height (p=0.0021), BMI (p=0.0004) and BMR (p=0.0001) were having significant impact on the physical activity ratio of women.
5. Further, as the age of women increased, they were found to be significantly (p=0.0039) more involved in cleaning activity, and similarly, BMI was also found to be associated with the involvement time of women in cleaning activity.

Introduction

Women living in rural areas are instrumental in managing the household as well as agriculture, which integrates significantly towards food production, well-being of the family, and rural economies [1]. Women, especially in the rural areas or in the poorer sections of the society, are burdened single handedly with domestic work such as cooking, cleaning, fetching water, taking care of children, and collecting fuel. These tasks are monotonous, physically taxing and time heavy, resulting in immense physiological strain [2]. The work of these women often goes unappreciated, and the daily tasks that need to be performed have to be physically demanding, translating to excessive energy expenditure, persistent tiredness, and enduring health complications [3]. To improve the efficiency of work, reduce work drudgery, and promote well-being and health of rural women, it is important to measure energy expenditure of these activities [4]. Notwithstanding, women's labor is integral to family survival and Women's domestic work is often disregarded in economic and health evaluations. Women's activities are described by involvement (the frequency, duration and intensity of activities) and physiological responses (heart rate, energy expenditure, and cardiovascular strain). Analyzing the subset of women's domestic work with respect to their participation, including the measurement of time, frequency and intensity, alongside their physiological responses, particularly heart rate, energy expenditure, and cardiovascular stress, is instrumental in evaluating health risks and designing appropriate ergonomic measures, advocating for appropriate labor-saving technologies and equitable gender policies (Rao et al. 2008). Understanding these factors is critical for crafting policies aimed at women's health in socio-economic development

frameworks [5]. Research shows women, mainly in the countryside of developing nations, carry out 80-90% of household and subsistence agriculture work [6]. This so-called “invisible workforce” participates in monotonous tasks that demand a considerable amount of physical effort, often surpassing the energy expenditure ceilings of recommended levels [7]. The chronic physiological strain caused by these tasks results in a “work-health paradox” where necessary household chores violate women’s well-being [8]. According to a study, 89% of communities forbid men from doing ‘women's work’ [9]. As early as age six, daughters take on household responsibilities [10].

Review of Literature

Energy Expenditure in Domestic and Agricultural Activities*:* Research on energy expenditure in rural environments originates from the seminal work of research [11], in which techniques developed for quantifying occupational energy costs. Subsequent studies in developing nations [12,13] revealed that agricultural activities (e.g., weeding, transplanting, threshing) necessitate considerable caloric expenditure, frequently surpassing 300 kcal/hour. Domestic tasks also exert significant physiological stress. Rural women in India expend approximately 1800–2200 kcal per day on domestic and agricultural labor, with water fetching alone consuming around 5–8 kcal per minute, contingent upon distance and load [14]. In line study similar findings discovered that the energy expenditure associated with firewood collection and manual grain grinding is comparable to that of moderate-intensity labor [15].

Gender Discrepancies in Workload and Health Consequences: Women in rural areas frequently engage in 12–14 hours of work each day, managing agricultural tasks (e.g., sowing, harvesting) alongside household responsibilities (e.g., cooking, childcare) [16]. This dual burden results in chronic energy deficiency (BMI <18.5 in 40–60% of cases) [17], musculoskeletal disorders (e.g., back pain from head-load carrying) [18], and negative maternal health outcomes (anemia, low birth weight) [19]).

Workload distribution and involvement pattern*:* Women spend 4–7 hours a day on household chores, frequently in addition to agricultural labor, according to studies conducted in developing countries [20].The majority of the day is spent by women in rural households performing a variety of necessary tasks. Water fetching usually requires one to three trips per day and takes around one to three hours. An extra one to two hours are needed for firewood collection, which is typically done every day or every other day. Cooking takes two to four hours and is necessary for preparing two to three meals a day. While childcare is a continuous responsibility that requires two to five hours of focused attention throughout the day, cleaning tasks take

about one to two hours each day. Women in sub-Saharan Africa devote 2.5 times as much time to household chores as men do [21]. Women and girls perform 90% of the water collection work in South Asia [22]. Due to distant sources, water fetching times increase during dry seasons [23]. During dry seasons, the time needed to collect water increases by 37% [24]. Energy costs rise by 18% for every kilometer to the water source [25]risk of injury by 23% [26]. Musculoskeletal stress is 22% higher during post-harvest times [27]. The collection of fuel wood in hilly areas requires more energy [28]. In South Asia, women work 4.7 hours a day providing unpaid care, compared to 0.8 hours for men [29]. In Sub-Saharan Africa, women devote 62% of their daily energy budget to household chores [30].

Profiles of activity by region: According to a comparative analysis of peer-reviewed studies conducted between 2019 and 2021, rural women in India, Kenya, and Nepal spend varying amounts of time on three essential domestic tasks: gathering fuel wood, processing food, and collecting water. According to study, women in India devote roughly 2.1 hours a day to collecting water, 1.7 hours to gathering fuel wood, and 2.3 hours to processing food [31]. Food processing takes 1.9 hours a day in Kenya, while water collection takes 3.4 hours and fuel wood gathering takes 2.5 hours [32]. Women in Nepal spend 1.8 hours a day collecting water, which is relatively less than men, but 2.2 hours a day gathering fuel wood, and 3.1 hours a day on average processing food [33].

Physiological Reactions to Energy: Most household chores are classified as moderate to high-intensity labor (3–6 METs*). The task and level of intensity determine how much energy is used for typical rural household tasks. About 250–400 kcal per hour are needed to fetch 20 liters of water, which translates to a MET (Metabolic Equivalent of Task) value of 5–6. With a MET value of 5–7 and an hourly cost of 300–450 kcal, gathering firewood is more physically taxing. While traditional cooking, although less demanding, still requires 150–250 kcal per hour with a MET value of 3–4, hand-grinding grain uses about 200–350 kcal per hour, or a MET value of 4–5. Dietary intake might not make up for daily expenditures that frequently surpass 2200–2500 kcal [15].

Effects on Health: Transporting water or firewood causes a 30–50% increase in heart rate [18]. Head load carrying (spinal compression) and prolonged squatting (knee osteoarthritis) are common causes of repetitive stress injuries (back pain, joint damage).Lack of sleep and persistent exhaustion [19]. Nutritional deficits brought on by high energy demands, such as anemia and low body mass index (Agarwal, 2018), risks to

reproductive health from heavy lifting, such as miscarriages and preterm births [26].

The above researches emphasized how rural women face disproportionate energy demands, with poor nutrition and restricted access to labor-saving equipment exacerbating health issues. There are high metabolic demands associated with manual household chores including gathering firewood, fetching water, and processing food, cleaning, dusting and mopping house, washing clothes etc. In the same line the present study was planned to look at how much time women spend on household tasks, the physiological and metabolic expenses, and the long-term health effects. The study's main goal was to quantify the energy costs related to a few household tasks that rural women in Haryana's Hisar regions frequently complete. This study intends to:

1. To document the involvement pattern of women in different domestic activities
2. To ascertain the energy cost of women involved in domestic activates

Materials and Methods

a. **Locale of the Study:** The present investigation was conducted in Hisar district, located in the state of Haryana, India. For the purpose of data collection, two villages—Dhobi and Mangali—within the district were selected using a random sampling procedure.

b. **Sample Selection:** A comprehensive list of domestic activities undertaken by women in the study area was compiled. Based on this list, participants were identified, and women who expressed willingness to participate in the study were purposively selected for inclusion in the sample

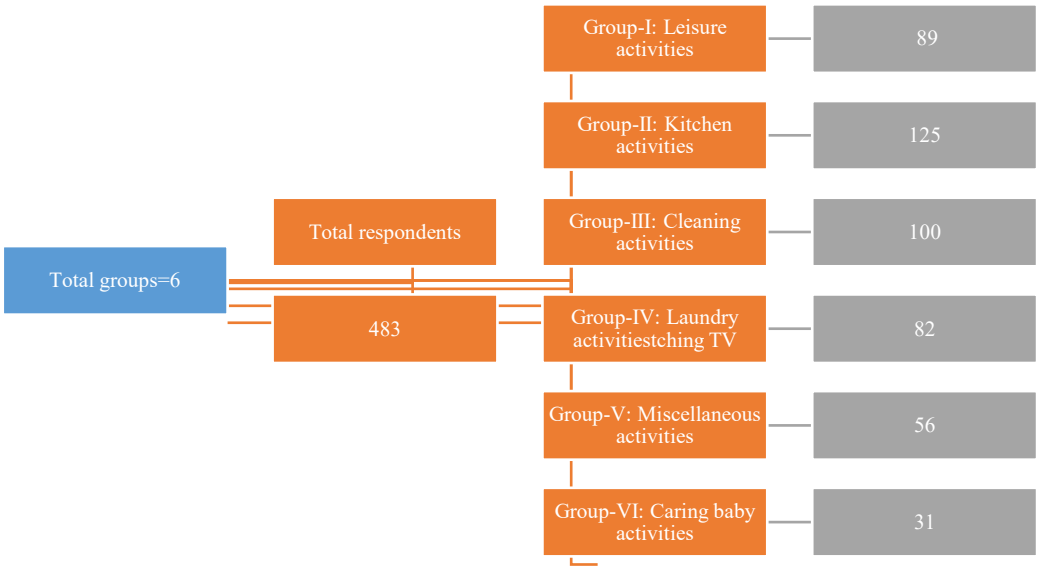


Fig.1. Sampling procedure

The figure 1shows how 483 respondents were distributed among six categories of everyday activities. The largest percentage of them (125 respondents) were involved in kitchen activities, followed by cleaning (100 respondents) and recreational (89 respondents) activities. A total 56 respondents engaged in miscellaneous activities, whereas 82 respondents did laundry and watched TV. With 31 responders, the smallest group was engaged in baby care. According to this distribution, the most frequently performed tasks were those related to the kitchen, while the least frequently performed tasks were those related to baby care.

c. **Variables and their measurement:** The following physical and physiological variables were taken during study

Variables and their measurement

Physical variables	**Measurements**
Age	Chronological age
Body weight	Bathroom weighing scale
Body height	Anthropometer
Body mass index	Quetelt's index
Physiological variables	
Heart rate	Polar heart rate monitor
Oxygen uptake	Oxylog (oxygen consumption, 1/min.) = 0.0155x HR-1.2248 [34]**(Singhand Gite, 2007)**
Energy expenditure (kcal h^{-1} min^{-1})	0.159x HR (bpm)-8.72 [35]. **(Varghese *et al*,. 1994) kj/min**
Basal metabolic rate (kcal min-1)	447.593 + (9.247 x weight in kg) + (3.098 x height in cm) – (4.330 x age in years) [36]. (**Garnet Health, 2016**)
Physical activity level (PAL)	Total energy required over 24 hours/ Basal metabolic rate over 24 hours [37] **(ICMR, 1990)**

The present study assessed a range of physical and physiological variables using standardized tools and established equations. Physical variables included chronological age, body weight measured with a bathroom weighing scale, and body height recorded using an anthropometer. Body Mass Index (BMI) was calculated using Quetelet's Index, derived by dividing weight in kilograms by height in meters squared.

Physiological variables measured were heart rate, recorded with a Polar heart rate monitor; oxygen uptake, estimated using the equation Oxygen consumption (l/min)=0.0155×HR−1.2248, as [34] and energy expenditure, calculated

through the formula 0.159×HR (bpm)−8.72(kcal/min) [35], expressed in kilojoules per minute.

Basal metabolic rate (BMR) was determined using the equation [36], while the Physical Activity Level (PAL) was computed as the ratio of total energy requirement over 24 hours to the basal metabolic rate over 24 hours, following ICMR guidelines [37]. This methodological approach ensured precise and reliable measurement of participants' physical and physiological characteristics.

d. **Tools and techniques of data collection:** A worksheet was developed containing all domestic activities along with physical and physiological variables of the respondents. Physical variables of the women were taken during rest and heart rate of the women was taken during the work.
e. **Analysis of data:** The data was tabulated and analyzed by using suitable tools and techniques

Results

Table: 1 Physical profile of women in different domestic activities

Activity group	Activities	N	Age (years)	Weight (Kg)	Height (cm)	BMI (kg/m²)	BMR (kcal/24hrs)
Group-I: Leisure activities	Rest	25	33.2±7.5	55.69±24.6	157.5±6.9	20.5±2.1	1392.3±65.6
	Group Talk	25	-	-	-	-	-
	Personal Care	25	-	-	-	-	-
	Watching TV	14	30.1±3.6	60.3±7.01	155.8±8.4	19.3±2.1	1358.3±68.3
Group-II: Kitchen activities	Utensil Cleaning	25	33.2±7.5	55.6±24.6	157.5±6.9	20.5±2.1	1392.3±65.6
	Dough Making	25	-	-	-	-	-
	Chapatti Making	25	-	-	-	-	-
	Vegetable Cutting	25	-	-	-	-	-
	Vegetable Cooking	25	-	-	-	-	-
	Tea Making	25	-	-	-	-	-
Group-III: Cleaning activities	Dusting	25	-	-	-	-	-
	Sweeping	25	-	-	-	-	-
	Wiping	25	-	-	-	-	-
	Washing Floor	25	-	-	-	-	-
Group-	Washing	25	-	-	-	-	-

IV: Laundry activities	Clothes (WM)						
	Washing Clothes (hands)	7	31.8±7.4	54.2±9.8	164.1±6.2	16.5±2.9	1319.7±102.5
	Rinsing Clothes	25	33.2±7.5	55.6±24.0	157.5±6.9	20.5±2.1	1392.3±65.6
	Drying Clothes	25	-	-	-	-	-
Group-V: Miscellaneous activities	Carrying Water	15	32.8±5.4	63.6±7.9	157.3±7.7	20.2±2.2	1381.3±68.3
	Taking Meal	13	34.0±4.7	65.6±6.3	157.6±5.7	20.7±1.5	1395.6±58.8
	Bed Making	17	33.5±4.5	64.5±7.2	157.3±7.1	20.4±1.7	1386.1±66.8
	Firewood arrangement	8	33.6±3.5	64.0±7.1	155.2±9.1	20.5±1.4	1039.4±66.3
	Amirah arrangement	3	22.0±0.0	51.3±7.2	156.6±1.4	16.3±2.3	1312.2±65.2
Group-VI: Caring baby activities	Breast feeding	8	29.0±3.3	49.7±9.4	162.9±5.9	15.2±2.8	1286.4±98.2
	Holding baby	8	33±8.1	53.8±9.9	160.2±6.6	16.8±2.9	1298.6±79.4
	Dressing baby	4	25.2±2.2	48.7±14.9	152.4±15.6	15.7±3.5	1261.1±183.1
	Bathing baby	6	25.3±8.7	46.4±13.8	142.2±41.3	14.8±4.2	1065.3±495.1
	Feeding baby	5	29.4±8.8	44.0±5.4	144.2±18.2	15.5±3.4	1298.6±79.4

BMI: Body Mass Index, BMR: Basal Metabolic Rate

The data in the Table 1 represent the physical profile of the women, including age, weight, height, BMI, and BMR. Women from groups I, II, III, and IV had an average age of 33.27.5 years, followed by a weight of 55.69±24.6kg and average height was 157.5±6.9cm. The BMI was found to be 20.5±2.1kg/m^2, which represents the mesomorph body type. The basal metabolic rate was found to be 1392.3±65.6 kcal/24 hrs. In Group-V, miscellaneous activities, and Group-VI, the number and types of women were different in each activity, so the physical profiles of the women also differed from activity to activity. In Group-V, the maximum values of age (34.0±4.7years) and weight (65.6±6.3kg) were found in the taking meals category. Maximum number of the women had mesomorph body type in activities such as carrying water (20.2±2.2kg/m^2), taking meals (20.7±1.5kg/m^2), making beds, firewood arrangements (20.4±1.7kg/m^2) and almirah arrangements (20.5±1.4kg/m^2) Women from group VI, caring for babies, were all from the severely underweight category (BMI less than 16.5kg/m^2).

Table- 2. Involvement pattern of women in domestic activities

Activity group	Activities	N	n	Involvement time (minutes)	Heart rate (beats/min)
Group-I: Leisure activities	Rest	89	25	32.96±20.48	66.16±4.59
	Group Talk		25	36.64±15.56	66.80±4.86
	Personal Care		25	23.88±8.44	75.08±8.79
	Watching TV		14	29.68±11.68	86.56±3.77
Group-II: Kitchen activities	Utensil Cleaning	125	25	53.52±19.46	101.08±4.42
	Dough Making		25	18.76±5.34	102.36±2.08
	Chapatti Making		25	46.96±19.81	101.52±1.82
	Vegetable Cutting		25	22.08±4.47	83.16±2.61
	Vegetable Cooking		25	32.56±10.20	96.5±2.78
	Tea Making		25	21.68±9.94	74.32±7.27
Group-III: Cleaning activities	Dusting	100	25	15.84±4.56	96.60±2.22
	Sweeping		25	24.68±7.77	97.84±2.03
	Wiping		25	24.16±6.97	106.28±3.59
	Washing Floor		25	16.52±4.40	100.12±3.27
Group-IV: Laundry activities	Washing Clothes (hands)	82	25	66.20±19.00	107.80±3.91
	Washing Clothes (machine)		7	45.71±9.32	88.28±9.46
	Rinsing Clothes		25	20.40±4.10	107.84±5.92
	Drying Clothes		25	13.20±2.20	105.48±4.02
Group-V: Miscellaneous activities	Carrying Water	56	15	19.33±3.06	103.00±2.24
	Taking Meal		13	9.79±2.04	78.79±2.15
	Bed Making		17	10.35±1.93	93.29±6.01
	Firewood arrangement		8	9.56±1.74	85.11±3.95
	Amirah arrangement		3	12.33±2.51	84.33±5.51
Group-VI: Caring baby activities	Breast feeding	31	8	2.85±0.64^{noc}	91.42±3.86
	Holding baby		8	2.5±0.92 ^{noc}	94.5±11.57
	Dressing baby		4	2.5±0.57 ^{noc}	87.1±5.47
	Bathing baby		6	2.58±1.42 ^{noc}	76.21±24.28
	Feeding baby		5	2.2±0.83 ^{noc}	77.8±9.23

NOC=number of children

The results in the Table 2 represent the involvement time and heart rate of the women in domestic activities. In Group-I, leisure activities, a total of 89 respondents was surveyed, and their maximum time involvement was found in group talk (36.64±15.56minutes) and rest (32.96±20.48minutes) activities. The highest heart rate was noticed while watching TV activity (86.56±3.77beats/min). In Group II: Kitchen Activities, a total of seven activities were examined, including utensil cleaning, dough making, chapatti making, vegetable cutting, vegetable cooking, and tea making. Women were found to be involved more in cleaning utensils (53.52±19.46 minutes) and

chapati making (46.96±19.81 minutes) activities. Further, their heart rate was found to be highest in dough making (102.36±2.08beats/min.) and utensil cleaning (101.08±4.42 beats/min.). Regarding Group III: cleaning activities, a total of 100 women were examined under four activities. Maximum involvement was found in sweeping (24.68±7.77min) and wiping activity (24.16±6.97 min.), besides the fact that heart rate was high in sweeping (106.28±3.59beats/min.) and washing floor activity (100.12±3.27 beats/min). Women were found to be involved for 66.20±19.00min. In washing clothes by hand with a heart rate of 107.80±3.91 beats/min. A total of 82 women were observed under group IV, i.e., laundry activity. Group V, miscellaneous activities, had four activities under which 56 women were investigated. Women were found to be involved for the maximum time (19.33±3.06 min.) in carrying out water activities with a heart rate of 103.00±2.24 beats/min. For group VI, caring for babies, six activities were observed. Women were found to have average of2.85±0.64 children. The highest heart rate was noticed in holding a baby (94.5±11.57 beats/min) and breast-feeding activity (91.42±3.86 beats/min).

Table 3. Physiological response of women in leisure activities

Activity	***Heart rate(beats/min)***	***Oxygen uptake(l/min)***	***Energy expenditure (kcal/min)***	***Physical activity Ratio***
Rest	66.16±4.58 c	0.11±0.07 b	1.79±0.72 c	1.86±0.76 c
Group talk	66.80±4.85 c	0.18±0.07 a	1.91±0.77 c	1.95±0.79 c
Personal care	75.08±8.79 b	0.06±0.03 c	3.21±1.39 b	3.32±1.39 b
Medical care	86.56±3.77 a	0.19±0.05 a	5.04±0.60 a	5.22±0.62 a

The Table 3 regarding the physiological response of women in leisure activities shows that heart rate (86.56±3.77beats/min), energy expenditure (5.04±0.60 kcal/min), and physical activity ratio (5.22±0.62) were found to be significantly higher in medical care activities than other leisure activities.

Table4. Physiological response of women in kitchen activities

Activity	**Heart rate(beats/min)**	**Time involved (mint.)**	**Oxygen uptake(l/min)**	**Energy expenditure (kcal/min)**	**Physical activity Ratio**
Utensil Cleaning	102.36±2.07a	18.76±5.34 c	0.36±0.03 a	7.55±0.33 a	7.83±0.58 a

Dough Making	102.36±2.07[a]	18.76±5.34 [c]	0.36±0.03 [a]	7.55±0.33 [a]	7.83±0.58 [a]
Chapatti making	101.52±1.82[a]	46.9±19.8[a]	0.34±0.02 [a]	7.42±0.29 [a]	7.69±0.43 [a]
Vegetable Cutting	83.16±2.61[c]	22.08±4.47 [c]	0.06±0.04 [c]	4.51±0.41 [c]	4.66±0.45 [c]
Vegetable cooking	96.5±2.78[b]	32.56±10.19 [b]	0.25±0.04 [b]	6.48±0.44 [b]	6.72±0.62 [b]
Tea Making	74.32±7.26[c]	21.68±9.94 [c]	0.07±0.01 [c]	3.09±1.15 [d]	3.25±1.23 [d]

Findings in the Table 4 show the physiological profile of women in kitchen activities like; chapatti making, dough making, tea making, utensil cleaning, vegetable cutting, and vegetable cooking. Women who were found to be involved in utensil cleaning, dough making, and utensil cleaning had a high level of heart rate, i.e., 101.52±1.82 beats per minute, 102.36±2.07 beats per minute, and 101.08±4.42 beats per minute, respectively. Similarly high level of oxygen uptake (7.55±0.33l/min, 7.42±0.29l/min and 7.35±0.71l/min) and energy expenditure (7.55±0.33kcal/min, 7.42±0.29kcal/min and 7.35±0.71kcal/min) was also noticed dough making, chapatti making and utensil cleaning activities.

Table 5. Physiological response of women in cleaning activities

Activity	**Heart rate(beats/min)**	**Time involved (mint.)**	**Oxygen uptake(l/min)**	**Energy expenditure (kcal/min)**	**Physical activity Ratio**
Dusting	96.6±2.21 [c]	15.8±4.56 [b]	0.27±0.03 [c]	6.63±0.35 [c]	6.88±0.54 [c]
Sweeping	97.8±2.03 [c]	24.16±6.97 [a]	0.29±0.03 [c]	6.83±0.32 [c]	7.08±0.51 [c]
Wiping	106.28±3.58 [a]	24.68±7.76 [a]	0.42±0.05 [a]	8.17±0.57 [a]	8.47±0.71 [a]
Washing floor	100.12±3.27 [b]	16.5±4.39 [b]	0.32±0.05 [b]	7.19±0.51 [b]	7.46±0.68 [b]

The results in the Table 5 reflect the level of physiological stress on women during cleaning activities. Findings explain that women were found to be having more physiological stress during wiping and washing the floor by having a high level of heart rate, (106.28±3.58 beats/min and 100.12±3.27 beats/min), oxygen uptake (0.42±0.05 l/min and 0.32±0.05 l/min) and

energy expenditure (8.17±0.57 kcal/min. and 7.19±0.51 kcal/min). The values of the physical activity ratio (8.47±0.71 and 7.46±0.68) reflect that these activities were high in exertion level.

Table6. Physiological response of women in laundry activities

Activity	Heart rate(beats/min)	Time involved (mint.)	Oxygen uptake(l/min)	Energy expenditure (kcal/min)	Physical activity Ratio
Washing clothes (hands)	107.80±3.91 a	66.20±19.0 a	0.41±0.06 a	8.05±0.63 a	8.34±0.78 a
Washing Clothes (machine)	88.28±9.46 c	45.71±9.32 b	0.14±0.14 c	5.31±1.51 c	5.85±1.79 b
Rinsing Clothes	107.84±5.92 a	20.40±4.11 c	0.44±0.09 a	8.42±0.94 a	8.74±1.15 a
Drying Clothes	97.80±3.91 b	13.20±2.19 c	0.29±0.06 b	6.83±0.62 b	7.08±0.15 b

Findings in the Table 6reflect the physiological wellbeing of women in laundry activities. Women who were rinsing and washing clothes by hand had a higher physiological load in the form of a high heart rate (107.84±5.92 beats/min and 107.80±3.91 beats/min), high oxygen consumption (0.44±0.09 1/min and 0.41±0.06l/min) and high-energy expenditure (8.42±0.94 kcal/min and 8.05±0.63 kcal/min). The physical activity ratio was also high among women doing rinsing (8.34±0.78) and washing clothes by hand (8.74±1.15).

Table7. Physiological response of women in miscellaneous activities

Activity	Heart rate(beats/min)	Time involved (mint.)	Oxygen uptake(l/min)	Energy expenditure (kcal/min)	Physical activity Ratio
Firewood arrangement	85.11±3.95 c	9.55±1.74 c	0.09±0.06 c	4.81±0.62 c	5.05±0.66 c
Almiraharrangement	84.33±5.15 c	12.33±2.51 a	0.08±0.08 c	4.68±0.87 c	5.16±1.06 c
Bed making	93.29±6.01 b	10.35±1.93 bc	0.22±0.09 b	6.11±0.95 b	6.37±1.03 b
Carrying water	103.00±2.2 a	19.33±3.06 a	0.37±0.03 a	7.65±0.35 a	7.99±0.45 a
Taking meal	78.78±2.15 d	9.78±2.04 c	0.03±0.03 d	3.80±0.34 d	3.95±0.42 d

The findings in the Table 7 represent the physiological response of women in miscellaneous activities. Women who were engaged for a long time (19.33±3.06minutes) in carrying water activity had more physiological stress involving a high level of heart rate (103.00±2.2 beats/min), high oxygen consumption (0.37±0.03l/min) and high energy expenditure (7.65±0.35kcal/min). The physical activity ratio was also high among the group of women involved in carrying water activity (7.99±0.45)

Table 8. Physiological response of women in child carrying activities

Activity	*Heart rate(beats/min)*	*Number of children*	*Oxygen uptake(l/min)*	*Energy expenditure (kcal/min)*	*Physical activity Ratio*
Breast feeding	91.75±3.84 ab	2.87±0.64 a	0.19±0.05 ab	5.86±0.61 ab	6.67±1.08 ab
Holding baby	94.50±11.57 a	2.50±0.92 a	0.23±0.17 a	6.31±1.84a	6.94±1.78 a
Dressing baby	87.00±5.47 abc	2.50±0.57 a	0.12±0.08abc	5.11±0.87 abc	5.98±1.71 ab
Bathing baby	80.16±13.43 bc	3.33±1.75 a	0.01±0.21c	4.02±2.13 bc	4.43±2.31 b
Feeding baby	77.80±9.23 c	2.20±0.83a	0.01±0.14c	3.65±1.46 c	4.51±1.93 b

Results in the Table 8 show the level of involvement of women in child carrying activities. A high level of heart rate was found among women holding babies (94.50±11.57 beats/min) followed by women involved in breastfeeding (91.75±3.84 beats/min). Further oxygen uptake (0.23±0.17l/min) and energy expenditure (6.31±1.84 kcal/min) were found to be high in women engaged in holding baby activities. It was concluded that women involved in holding baby and breastfeeding activities had a high physical activity ratio i.e. 6.94±1.78 and 6.67±1.08, respectively.

Table 9: Correlation between time involvement and physical and physiological profile of women

Physical Variable	Correlation value	Group-I	Group-II	Group-III	Group-IV	Group-V
Age (years)	"r" "p"	0.13305 0.1869	0.06523 0.4277	**0.28628 0.0039**	0.08125 0.4681	0.02371 0.8598
Weight(kg)	"r" "p"	0.13241 0.1891	0.10086 0.2194	0.19777 0.0515	0.04633 0.6794	0.00778 0.9538
Height(cm)	"r" "p"	0.13879	0.08241 0.3160	0.04643 0.6465	0.03672 0.7433	0.06093 0.6496

		0.1685				
BMI(kg/m²)	"r" "p"	0.0864 8 0.3922	0.07893 0.3370	**0.2363 1 0.0179**	0.03708 0.7408	0.03075 0.8188
BMR(kcal/24hrs)	"r" "p"	0.1446 4 0.1511	0.11356 0.1665	0.17084 0.0892	0.03643 0.7453	0.01907 0.8870
Heart rate(beats/min)	"r" "p"	**0.481 96 0.000 1**	**0.34274 0.0001**	**0.3400 4 0.0005**	**0.42892 0.0001**	**0.75450 0.0001**
Oxygen uptake(l/min)	"r" "p"	**0.481 96 0.000 1**	**0.34274 0.0001**	**0.3400 4 0.0005**	**0.42892 0.0001**	**0.75450 0.0001**
Energyexpenditure (kcal/min)	"r" "p"	**0.481 96 0.000 1**	**0.34274 0.0001**	**0.3400 4 0.0005**	**0.42892 0.0001**	**0.75450 0.0001**
Physical activity Ratio	"r" "p"	**0.477 62 0.000 1**	**0.31910 0.0001**	**0.2314 3 0.0205**	**0.42357 0.0001**	**0.7949 0.0001**

Significant at p<0.05
Highly significant at p<0.01

Table 9 represents the correlation between time engagement in different domestic activities and the physical and physiological profiles of women. Data revealed that the age of the women was found to be significantly (p=**0.0039)** correlated with their time involvement in cleaning activity, which means that as the age of the women increased, they were found to be more involved in cleaning activity. Results show that as the BMI of women increased, they tended to engage more in cleaning activities. Further data show that the heart rate, oxygen uptake, energy expenditure, and physical profile of women during domestic activities were found to be affected by their time involvement in all activities. Results show that women who were found to be involved for a long time in their respective work had a higher heart rate, high oxygen uptake, high energy expenditure, and a higher physical activity ratio.

Table10. Correlation between number of children and physical and physiological profile of women

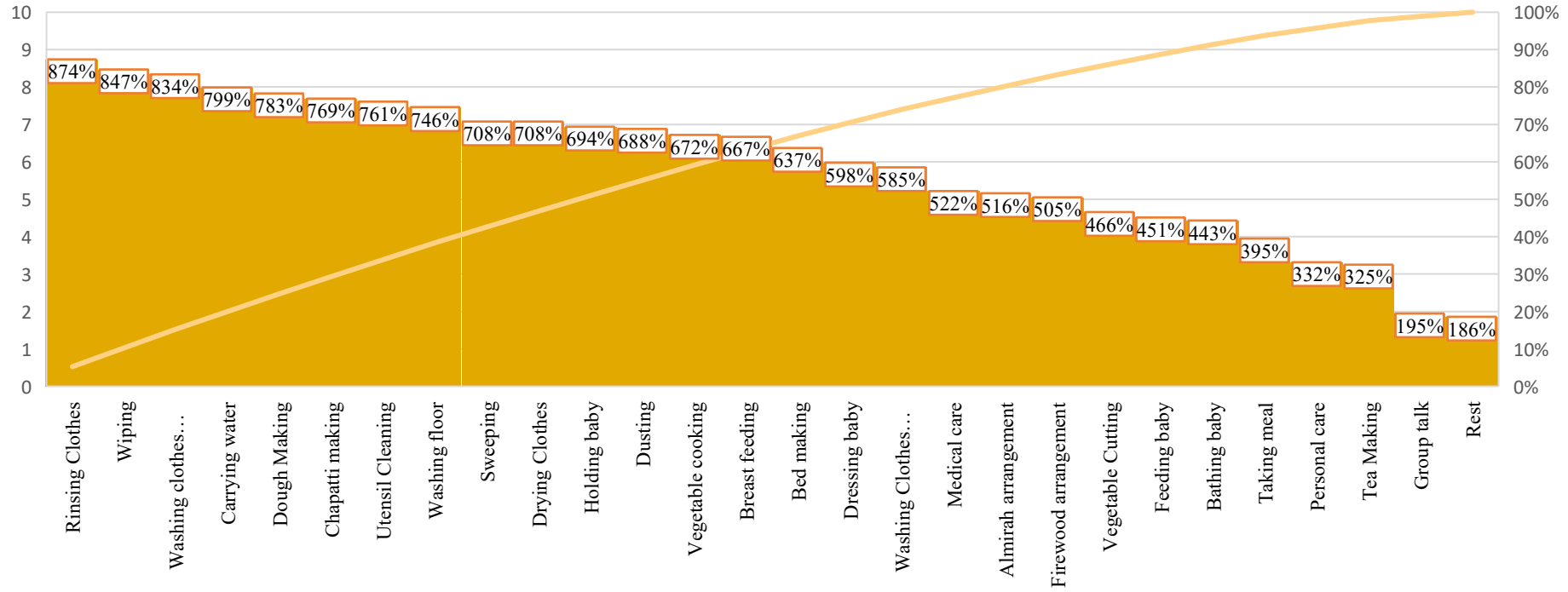
Physical Variable	Correlation value	Group-IV
Age (years)	"r" "p"	**0.45858** **0.0095**
Weight(kg)	"r" "p"	0.05259 0.7787
Height(cm)	"r" "p"	0.34058 0.0608
BMI(kg/m²)	"r" "p"	**-0.8326** **0.0005**
BMR(kcal/24hrs)	"r" "p"	0.04058 0.608
Heart rate(beats/min)	"r" "p"	0.3656 0.0532
Oxygen uptake(l/min)	"r" "p"	0.3656 0.0532
Energy expenditure (kcal/min)	"r" "p"	0.3656 0.0532
Physical activity Ratio	"r" "p"	**0.42097** **0.0051**

Significant at p<0.05

Highly significant at p<0.01

Findings in the Table 10 revealed a correlation between the number of children women have and their effect on their physical and physiological health. The table gives a clear picture that age was found to be significantly (p=0.0095) correlated with the number of children, and as the age of women increased, they were found to be having more children. Further, the BMI of women was found to be negatively correlated (p=0.005) with the number of children they have, indicating that as the number of children a woman has increases, her body mass index decreases. The level of heart rate, oxygen uptake, and energy expenditure were also found to be increasing as the women's number of children increased. Findings show that the physical activity ratio was found to be increasing with the number of children a woman has.

Fig. 10. Physical activity ratio of different domestic activites



The results in Fig. 2 show the physical activity ratio of different domestic activities. Rinsing clothes activity had the highest PAR (8.74), followed by wiping (8.47) and washing clothes by hand (8.34). In the study, it was revealed that the lowest physical activity ration (cost of energy expenditure) was fund lea in rest activity (1.86), followed by group talk (1.95) and tea making (3.25). The data in the figure clearly explain that maximum activity was having a physical activity ratio greater than 5.00.

Difference in energy costs of activities studied and recommended (WHO): Findings revealed that in all the categories of domestic activity, the level of physical activity ratio was found to be higher than what WHO suggested. From leisure to kitchen, cleaning, laundry, and childcare, women were found to be using more energy than studied by the WHO. The recommended range of PAR for leisure activity was 1.0-1.4, but in the current study, women had PAR as high as 5.22. Further, in kitchen activities, the PAR values were found to be 7.83 and 7.69 for dough making and chapatti making activities, respectively, and 3.4 and 2.4 as per recommendation. Similarly, the cleaning activity level of PAR was 8.47 in wiping activity, which was 3.4–4.4 in recommendation. For washing clothes by hand, 3.53 (PAR) was found in the previous study, which was found to be 8.34 in the present study. Further, for childcare activities, the PAR range was 1.9 to 3.5, and it was 4.4 to 6.9 in the present study.

Table11. Difference in energy costs of activities in studied and recommended (WHO)

Activity group	Activities	Physical activity ratio	WHO recommended
Group-I: Leisure activities	Group talk	1.95	1.0 – 1.4
	Medical care	5.22	1.0 – 1.4
	Personal care	3.32	1.0 – 1.4
	Rest	1.86	1.2
Group-II: Kitchen activities	Chapatti making	7.69	2.4
	Dough Making	7.83	3.4
	Tea Making	3.25	
	Utensil Cleaning	7.61	1.7
	Vegetable Cutting	4.66	1.5
	Vegetable cooking	6.72	1.5 – 1.8
Group-III: Cleaning activities	Dusting	6.88	
	Sweeping	7.08	2.3
	Wiping	8.47	3.4 – 4.4
	Washing floor	7.46	4.4
Group-IV: Laundry activities	Washing clothes (hands)	8.34	3.53
	Rinsing Clothes	8.74	
	Washing Clothes (machine)	5.85	
	Drying Clothes	7.08	
Group-V: Miscellaneou	Firewood arrangement	5.05	

s activities	Almirah arrangement	5.16	
	Bed making	6.37	3.4
	Carrying water	7.99	4.5
	Taking meal	3.95	1.4
Group-VI: Caring baby activities	Breast feeding	6.67	-
	Holding baby	6.94	1.92
	Dressing baby	5.98	2.5
	Bathing baby	4.43	3.5
	Feeding baby	4.51	1.9

Discussion:

The present study titled 'Measurement of energy cost of selected household activities performed by rural women of Haryana' was undertaken on Women of Haryana to assess their energy cost involved in household activities. For present investigation. Total 483 women respondents were investigated from six categories of everyday activities. The largest percentage of them (125 respondents) was from kitchen activities, followed by cleaning (100 respondents) and recreational (89 respondents) and miscellaneous activities (56 respondents). Whereas 82 respondents were observed from laundry and watched TV tasks while a small group of women (31 responders) was from baby care activities. The present study assessed a range of physical and physiological variables using standardized tools and established equations. This methodological approach ensured precise and reliable measurement of participants' physical and physiological characteristics.

In present study women from different groups had an average age of 33.27.5 years, followed by a weight of 55.69±24.6kg and average height was 157.5±6.9cm. The BMI was found to be 20.5±2.1kg/m^2, which represents the mesomorph body type. The basal metabolic rate was found to be 1392.3±65.6 kcal/24 hrs. Women were found to be involved more in cleaning utensils (53.52±19.46 minutes) and *chapati* making (46.96±19.81 minutes) activities. Further, their heart rate was found to be highest in dough making (102.36±2.08beats/min.) and utensil cleaning (101.08±4.42 beats/min.). Regarding, cleaning activities, maximum involvement was found in sweeping (24.68±7.77min) and wiping activity (24.16±6.97 min.).

Results revealed that cleaning activities like wiping (106.28±3.58 bpm), washing floors (100.12±3.27 bpm), and rinsing clothes (PAR 8.74) all exhibit noticeably higher heart rates, indicating that they fall into the heavy workload category. These findings closely align with earlier research done in same line and exhibited that Indian women's cardiac strain and energy expenditure are increased when they mop the floor, squat, and wash their clothes by hand [34]. Similar heart rate and oxygen uptake values were

recorded during wet household tasks, confirming that these activities are physiologically taxing [35].

According to studies cleaning and laundry tasks routinely surpass moderate workload limits [36]. Therefore, the current study supports the ergonomic evidence that shows a significant cardiovascular burden is associated with wet, repetitive, and forceful household tasks.

Activities like wiping (8.17±0.57 kcal/min), washing floors (7.19±0.51 kcal/min), and carrying water (7.65±0.35 kcal/min) all require high metabolic energy, according to energy expenditure values. Similar results have recorded in a study that Indian women who perform household chores frequently reach energy expenditure ranges comparable to those observed in industrial occupations [37]. Domestic work, especially which involves handling water, causes a prolonged cardiac load and high oxygen consumption [38].

Women who carried water had heart rates of 103±2.2 bpm and high oxygen uptake. These results are corroborated same results in line that load-bearing and carrying tasks have the highest biomechanical and metabolic demands in field settings [39] and women who fetch water in rural areas have much higher daily energy costs and higher levels of cardiac stress [40].

The moderate-to-high heart rate values during breastfeeding (91.75±3.84 bpm) and baby-holding (94.50±11.57 bpm) indicate that childcare entails a significant static muscular load because that isometric muscle engagement during static tasks even those without significant movement imposes significant cardiovascular and postural strain [41].Strong relationships between anthropometric traits and the metabolic cost of physical tasks [42] provide evidence that household activities constitute high physiological workload**,** importantly, the findings reinforce that rural women's daily household tasks are comparable in intensity to recognized moderate-to-heavy occupational labor [43]. The integration of biomechanical factors (duration, posture), physiological parameters (HR, VO_2, PAR), and demographic characteristics offers a comprehensive workload profile, advancing the understanding of women's unpaid labor an area frequently neglected in mainstream ergonomics research.

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