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Measurement of Fitness of Aviation Personnel of SAB System : Acquisition of Resting Heart Beat and Comparison of Males & Females

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Abstract: *Aviation Personnel play a role as the catalyst of the Aviation Industry. Personnel that are physically fit would contribute in an optimum manner to the alleviation of the industry. Its imperative for these workers to be fit as it involved safety and safety is paramount in aviation. Aviation Personnel consist not only pilots or cabin crews but also maintenance workers, designers, academicians, engineers, suppliers, and others that are involved in aviation as a whole. Our research measured the physical fitness of Aviation Personnel from an aviation company called SAB System where the measurement was actuated via heartbeat analyses. We also went further by comparing the heartbeats of the male and female workers at this particular company.*

Keywords: *Fitness in Aviation, Physical Fitness, Heartbeat Measurement, Comparison of Male and Female*

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I. INTRODUCTION

In aviation it is always important to be vigilant and physically fit in order to retain or increase the performance of our work. Having a good performance, for example able to fix an aircraft efficiently and correctly, would intact safety and perhaps increase it as well. Our investigation upon aviation workers was propelled by the need to retain safety and we had measured 16 aviation workers from SAB System. SAB System is an aviation company based in Shah Alam Malaysia and has 50 man years experiences among it's workers.

The fitness of the workers from SAB System was measured via heartbeat analysis where the data of their heartbeats were taken and acquired at the end of their peak productive time. The selection of this time period is purely arbitrary as we were interested and curious as to the nature of their fitness as this particular period. Pope mentioned this period in his paper where he had studied the performances of students at this selected period [1]. The heartbeat data that we obtained from the workers were from the time range of 11am till 12pm (GMT +8).

Wiegmann indicated that most accidents had occurred due to human factors [2]. These human factors could be mistakes, unprepared workers, or others. There were also instances where the individuals were not physically fit to perform the work and thus inducing mistakes which cause maladies [2].

Hobbs stipulated that various maladies in aviation occurred due to under performing employees and in depth investigations upon these issues uncovered the fact that some workers were physically unfit [3]. Hobbs mentioned that the safety issue was mostly concentrated upon those that work directly upon aircraft such as maintenance workers, pilots, flight engineers, and others [3].

Heikkila in his patent had inferred that an individual physical fitness could be gauged by examining his or her heartbeat [4]. He also mentioned that during any physical activity, the level of stress exerted upon the individual could also be quantified by measuring the heartbeat of the individual [4]. Heikkila had invented a device that would ascertain the amount of stress that is induced upon a person [4].

Meersman had studied 72 individuals and he measured their fitness via heartbeat analysis [5]. He had observed the differences between those that were physically active with those that were not. He even mentioned that age had contributed to the alteration of the rate of heartbeat of individuals and this is the notion that propelled us to include age in our study of personnel of SAB System.

Lutfi had concluded that there is a difference between the heartbeat of males and females [6]. He had performed experimentation upon male and female subjects and it was shown that males had lower heart rate than females [6]. Lutfi conducted this experimentation upon 80 males and 76 females. The results was

interesting and we had followed suit by acquiring data of heartbeat of male and female workers and we had done comparison between these 2 sets of data. Our results are shown in the Results Section of this paper.

Huxley had studied the physiology of males and females and she stated that there is a difference in the heart rate of males and females [7]. She pointed out that men and women would regulate their internal system in order to gain homeostasis [7]. The different ways to achieve homeostasis led to the differences in males and females. This is of particular interest to us which can be seen by our approach in this research.

II. LITERATURE REVIEW

Virovac in his paper had elucidated the causes of tragedies in aviation and he pointed out that errors by humans were to be blamed for most accidents [8]. The fitness of the workers played a vital role in eradicating accidents or issues. Virovac had studied 28 cases to came out with his deduction [8].

Sun had studied occurrences in aviation and he made a statement that human actions were the reasons behind certain safety issues in aviation [9]. Sun proposed a new method to perform analysis upon errors originated from humans and this method was an enhancement of EEAM which stands for Elementary Events Analysis Method [9]. Sun intended to improve the safety ecosystem of the aviation industry and had pressed forward with an enhanced EEAM that was said to be "easy" in its application [9].

Drury had compiled several examples of incidents that were derived from human errors. Drury further mentioned that there were 2 types of causes of aviation maladies : latent cause and active cause [10]. We were concerned about these causes where our research is significant in preventing snowballing of latent causes. It's better to eradicate minute predicaments before it gets bigger.

The relationship between heartbeat and fitness exist where Silva had agreed with this notion. Silva had conducted an investigation where 695 school children were taken as subjects and Silva concluded that heartbeat could be used to measure the fitness of individuals [11]. Silva even mentioned that the resting heartbeat provided an easy mean to gauge the fitness of men and women [11].

Jensen stipulated that resting heart rate is an indicator of one's fitness where there were several classifications of fitness based upon the value of the resting heart rate [12]. Jensen studied longitudinal data of middle aged men and several tools were used to gain the measurement of fitness. Tools that were used were ECG Machine and Astrand Bicycle Ergometer [12].

The relationship between physical fitness and resting heart rate had been studied by Quan where he deducted that the relationship existed [13]. This was based upon evaluation of 2328 young adults that were subjected to numerous muscular strength and cardiorespiratory testings [13]. This had guided us to measure the heart beat of aviation workers in order to gain their fitness classification.

Purkiss had outlined the differences between males and females in terms of their physiology. She found out that one such difference is the rate of heartbeat where the difference is significant between men and women [14]. She went further by investigating other parameters as well. Other parameters that were studied were cardiac output, stroke volume, and blood pressure [14].

Maris also agreed with Purkiss where she had examined several subjects and made a conclusion that heartbeats of males and females were different [15]. Maris had also measured the blood pressure of the subjects along with their pulse pressure and this had led to her conclusion [15].

According to Rosenberg, on average the heartbeat of females is usually much higher than the heartbeat of males [16]. Rosenberg had quoted the work of Ramaekers [17] to complement his statement. We had measured the average heartbeat of female and male workers at SAB System and comparison was made and the result was quite interesting. We presented this result in the Results Section and discussion regarding this is in the Discussion Section.

III. METHODOLOGY

The methodology of our research is shown in Figure 1.

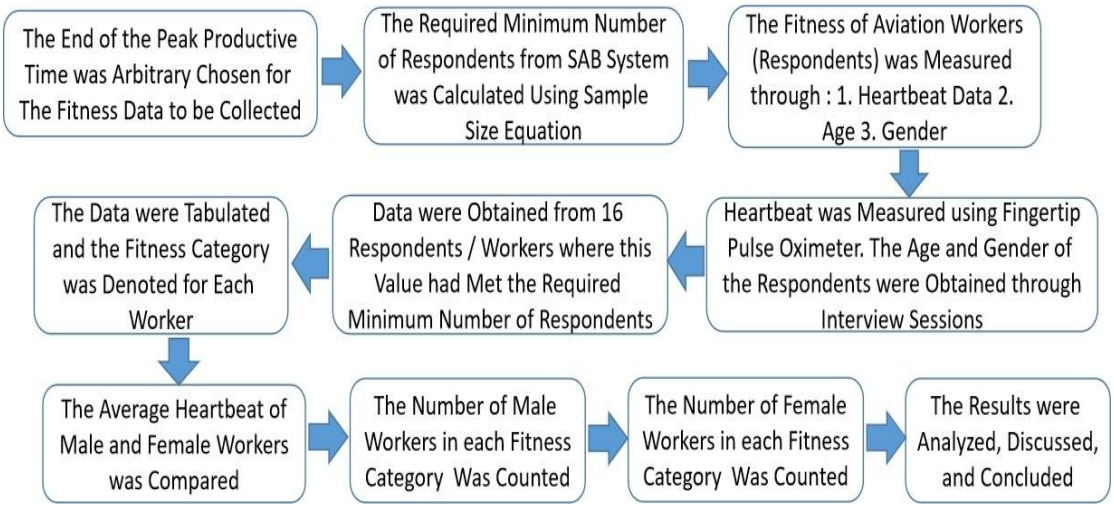

Figure 1. The Methodology of the Evaluation of Fitness

Since there were numerous periods of time where heartbeat data could be collected, we arbitrary decided to perform measurement of heartbeat of the aviation workers at the end of the Peak Productive Time. We were curious to the nature of the data obtain at this particular time and we had noted the time stamp of each individual in the Results Section. The Peak Productive Time was denoted to be from 11am till 12 noon (GMT +8) [1].

The required minimum number of respondents was calculated using the sample size equation. The values that were inserted into the equation were : Population Size = 18 , Confidence Level = 80% , and Margin of Error = 5.5%. The total number of workers at SAB System was 18 which was the Population Size. The value we obtained after the calculation was 16 (the required minimum number of respondents). We had collected data of heartbeat, age, and gender in order to evaluate the fitness of workers of SAB System. Heartbeat data were collected using a Fingertip Pulse Oximeter and the data of age and gender were collected through one on one interview with the workers.

Overall we had obtained data from 16 workers of SAB System which met the required minimum number of respondents. The data collected were then tabulated. The tabulations were shown in Tables 3 and 4. The classifications of fitness shown in Tables 3 and 4 were based upon Table 1 (for men) and Table 2 (for women). We then compared data of males and females.

For males, we had numerically counted the number of workers that were classified in each fitness category. This was also done for females. The results that we had obtained were then analyzed, discussed, and concluded.

Table 1. Male Resting Heart Rate Category [18]

Resting Heart Rate Chart for Men							
Age in Years	Heartbeats Per Minute						
	Athlete	Excellent	Good	Above Average	Average	Below Average	Prescribe Exercise
18-25	49-55	56-61	62-65	66-69	70-73	74-81	82+
26-35	49-54	55-61	62-65	66-70	71-74	75-81	82+
36-45	50-56	57-62	63-66	67-70	71-75	76-82	83+
46-55	50-57	58-63	64-67	68-71	72-76	77-83	84+
56-65	51-56	57-61	62-67	68-71	72-75	76-81	82+
65+	50-55	56-61	62-65	66-69	70-73	74-79	80+

Table 2. Female Resting Heart Rate Category [18]

Resting Heart Rate Chart for Women							
Age in Years	Heartbeats Per Minute						
	Athlete	Excellent	Good	Above Average	Average	Below Average	Prescribe Exercise
18-25	49-55	56-61	62-65	66-69	70-73	74-81	82+

26-35	54-59	60-64	65-68	69-72	73-76	77-82	83+
36-45	54-59	60-64	65-69	70-73	74-78	79-84	85+
46-55	54-60	61-65	66-69	70-73	74-77	78-83	84+
56-65	54-59	60-64	65-68	69-73	74-77	78-83	84+
65+	54-59	60-64	65-68	69-72	73-76	77-84	84+

IV. RESULTS

The results are shown in Tables 3 and 4 and Figures 2, 3, and 4.

Table 3. Results for Male Employee

Employee	Gender	Age (Years)	Heartbeats Per Minute (Resting)	Time Taken (GMT +8)	Category
Employee1	Male	25	82	11.02 am	Prescribe Exercise
Employee2	Male	25	75	11.05 am	Below Average
Employee3	Male	23	68	11.08 am	Above Average
Employee4	Male	24	97	11.11 am	Prescribe Exercise
Employee5	Male	23	88	11.15 am	Prescribe Exercise
Employee6	Male	23	99	11.19 am	Prescribe Exercise
Employee7	Male	49	93	11.53 am	Prescribe Exercise
Employee8	Male	47	68	11.57 am	Above Average

Table 4. Results for Female Employee

Employee	Gender	Age (Years)	Heartbeats Per Minute (Resting)	Time Taken (GMT +8)	Category
Employee9	Female	24	67	11.23 am	Above Average
Employee10	Female	24	88	11.26 am	Prescribe Exercise
Employee11	Female	27	78	11.29 am	Below Average
Employee12	Female	23	85	11.34 am	Prescribe Exercise
Employee13	Female	23	78	11.37 am	Below Average
Employee14	Female	22	88	11.42 am	Prescribe Exercise
Employee15	Female	42	73	11.46 am	Above Average
Employee16	Female	35	94	11.50 am	Prescribe Exercise

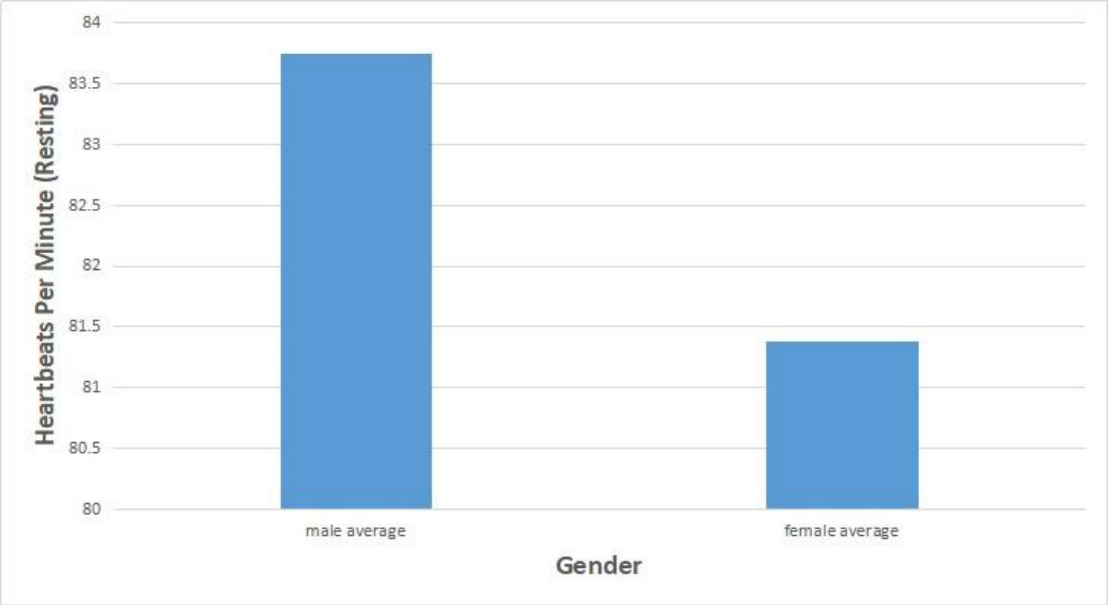

Figure 2. Comparison of Average Heartbeats between Male and Female

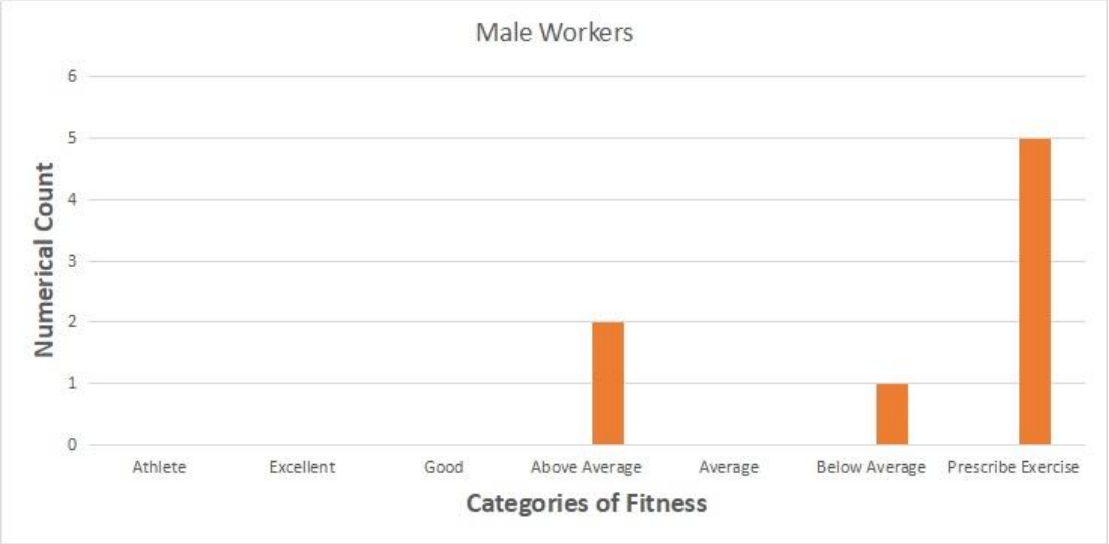

Figure 3. Numerical Count of Male Workers in Each Fitness Category

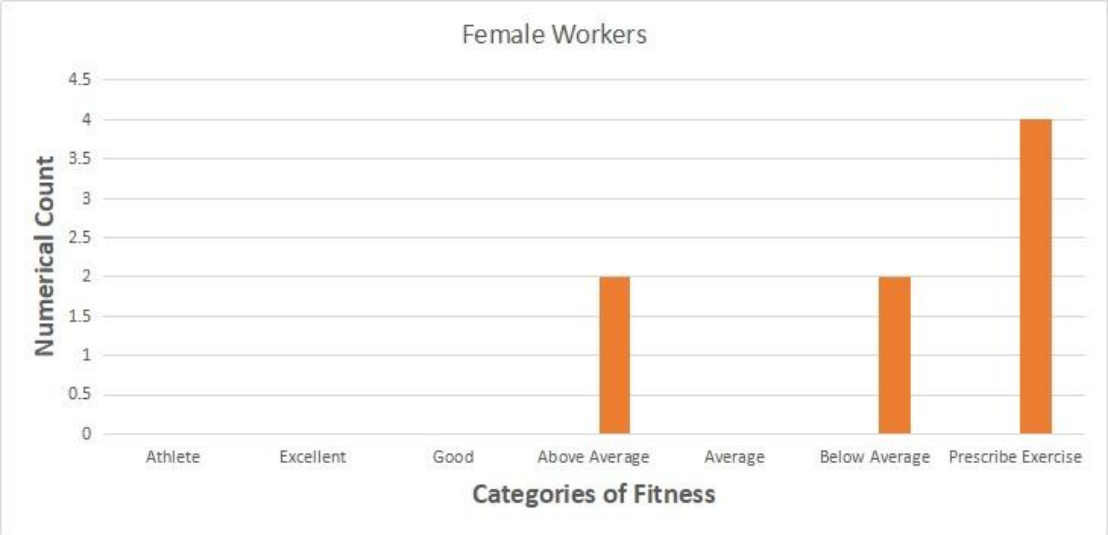

Figure 4. Numerical Count of Female Workers in Each Fitness Category

V. DISCUSSION

Table 3 showed the resting heart rate of male workers. The lowest value was 68 heartbeats per minute and it was exerted by 2 employees which were 23 and 47 years old respectively. Pertaining to fitness level, both of these employees were classified as above average. The 47 year old male was applauded as he was still in top notch shape even though he's almost 50 years old. We had interviewed this individual and he revealed that he had regularly exercised twice a week where each exercise session was 2 hours long. His regime of exercise consisted of badminton and golf. As can be seen from the time stamps in Table 3, all of the males were measured from 11.02am till 11.57am which conformed to the period End of Peak Productive Time.

Table 4 showed the results for female employees. The highest resting heartbeat was recorded by a female employee who was 35 years old. This employee had a resting heartbeat of 94 heartbeats per minute. Perhaps age had played a factor in her ranking since majority of female employees were under 30 years old. We had interviewed this particular employee and she indicated that she usually exercised 3 times per week. Perhaps more assessment was needed before prescribing certain exercises to her. There maybe under laying health problems that were not recorded by our measurement process.

There was a female employee that had a resting heartbeat of 67 heartbeats per minute. She had indicated that she did not exercise regularly and was not attached to any dietary regime. She however had a weight of only 36kg. Perhaps her weight had contributed to her low heartbeat value. This particular employee was only 24 years old.

Peering at Figure 2, one can observe that the average heartbeat of males was higher than female. This contradicted the statement from Rosenberg [16] which stipulated that heartbeats of females were usually higher than males. This was quite interesting, to find contradictory results from our measurements. Its plausible that our sample was not big enough and hence the contradictory results. Also it has to be reminded, pertaining to our results, that the difference between the average heartbeat of males and females was only 2.375 heartbeats per minute. This perhaps is not significant and if more subjects were sampled the outcome would perhaps follow the norm.

Looking at Figure 3, the male workers were categorized in accordance to their fitness classification. 2 male workers were "above average" in their fitness, 1 worker was "below average", and 5 workers were advised to expedite their fitness regime (increasing their physical exercises or begin as soon as possible a fitness programme). We however caution that there should be other forms of measurements in order to holistically gauge the level of fitness of the male workers.

Peering at Figure 4, 2 female workers were in the "above average" category pertaining to their physical fitness. 2 were in the "below average" category while 4 female workers were advised to expedite their fitness regime. It can be seen that there was equivalent number of males and females in the "above average" category while more male workers were advised to expedite their fitness regime in contrast to females.

VI. CONCLUSIONS

We had measured the physical fitness of Aviation Personnel at an aviation company in Malaysia. The measurement was via heartbeat investigation with supplemental information (age and gender). We had taken the measurement at the end of the workers peak productive time as we were curious on the outcome. The results were mixed where there were workers, male and female, that were exceptionally fit. But there were also workers that were advised to undergo peripheral physical exercise. We had compared data of male and females and differences did exist. Our results had also indicated that physical exercises and body weight acted as factors that influenced the fitness of individuals.

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