COMPARATIVE ANALYSIS OF PHYSICAL TESTS OF THE NAVY STAFF. COASTAL AND MOUNTAIN REGION

Análisis comparativo de las pruebas físicas del personal naval. Región Costa y Sierra

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ABSTRACT

Introduction: The physical fitness tests, from the biological point of view, are a scientific procedure performed under standard conditions that measure several characteristics in an empirical way, specifying the medical-biological measurements as essential indicators of the professional performance of army militaries. **Objective:** This paper is aimed at comparing the performance of the militaries evaluated in the coast and mountain regions using four tests (race, hip flexion, swimming and rope climbing) corresponding to the physical tests of the Navy staff in the first semester of 2015. **Methods:** The study was observational, retrospective, analytic and transversal, in which were evaluated men and women aged 18-30. **Results:** The statistical analysis reported that the male group of the mountain compared to the one of the coast showed a significant difference in the disciplines that evaluate strength (hip flexion and rope climbing). **Conclusions:** The study showed that the environmental factors (e.g: barometric pressure, temperature, humidity) have no influence in the physical tests of strength performed in the mountains. In addition, it is important to note that the male and female performance of the two regions in the swimming tests overcame the expectation of the evaluation charts. For that reason, as a recommendation, it is necessary to carry out a new study to standardize and determine the adequate cut off points for the respective physical tests.

Keywords: Physical Testing, Naval Staff; Ecuador

RESUMEN

Introducción: Las pruebas de condición física, desde el punto de vista biológico, son un procedimiento científico realizado bajo condiciones estandarizadas que miden diversas características de forma empírica, especificándose las mediciones médico-biológicas como indicadores fundamentales del rendimiento profesional de militares del ejército. **Objetivo:** El Objetivo de la investigación es comparar el rendimiento de los evaluados en la región costa y sierra utilizando cuatro test (carrera, flexiones de cadera, natación y trepar cabo) correspondientes a las pruebas físicas del personal Naval en el primer semestre del año 2015. **Métodos:** El estudio llevado fue de tipo observacional, retrospectivo, analítico y transversal, en el cual se evaluó a los hombres y mujeres de edades comprendidas entre 18 y 30 años. **Resultados:** En el análisis estadístico se observó que en el grupo masculino de la sierra comparado con el de la costa, hubo diferencia significativa en las disciplinas que evalúan fuerza (flexiones de cadera y trepar cabo). **Conclusiones:** El estudio evidenció que los factores ambientales (ej. presión barométrica, temperatura, humedad) no ejercen influencia en las pruebas físicas de fuerza realizadas en la región sierra. Además, es importante señalar que el rendimiento masculino y femenino de las dos regiones en las pruebas de natación sobrepasó las expectativas de las tablas de evaluación. Por tal motivo, como recomendación se debe realizar un nuevo estudio para estandarizar y determinar los puntos de corte adecuados para las respectivas pruebas físicas.

Palabras Clave: Pruebas Físicas, Personal Naval; Ecuador

INTRODUCTION

Ecuador's Navy, as an institution of the Armed Forces, works everyday with its most precious content –the human resource- that is why, through the capability of the staff it develops the Naval Power in order to contribute to national defence and the public security of the state. The essential goal of this institution is to have a well trained staff with excellent physical and combat conditions, since the military activities are inherent to the conditional and determining skills (1,2,3) of the Navy Force.

One of the institutional goals of Ecuador's Navy is: "to increase the development and management of the human talent"; this is possible through courses, training and specialization of the overall staff, which allows the institution to watch for the fulfilment of this goal. It is worth noting that the physical-military readiness is part of the curricular terms of the Navy career plan (4).

The law for the Armed Forces staff in its 91st article states that as part of the Annual Qualification it is necessary to include the Physical Fitness of the soldier,

considering it a 20% of the final grade. Therefore, all militaries must fulfil the written dispositions in laws and regulations (5).

The direction board of the Navy Force Physical Tests, establishes in general for all the subordinate divisions, that the physical training must be three days a week in order to get an evaluation every six months, without making difference among evaluation terms of each region of the country, since the Navy has military units in the four natural regions of Ecuador with different environment conditions.

Ecuador, as part of South America, is crossed by the Andes Mountains and this geologic formation divides its continental structure into three natural regions: Coast, Sierra, Amazon and Galapagos Islands. (6,7).

The coastal or plain region, which is part of the biogeographic Chocó[1], is located in the western part of the country and is made up by plains, hills and low hillocks; it also counts of fluvial sources that flow into the Pacific ocean, a place that holds most of the naval units, located in the provinces of Esmeraldas, Manabí, Santa Elena, Guayas and El Oro. (8)

The sierra or mountain region limits with the Amazon to the east and with the coast to the west, is made up by a mountain range belt running from the North to the South of the country, covering an approximate distance of 650km long and 100 km-450km wide, with an average height of 4 000 meters over the sea level (mosl) (9). In this region the navy of Ecuador counts on military units of the province of Pichincha and the naval staff serving in units of the Joint Command of the Armed Forces (CCFFAA in Spanish) in the provinces of Imbabura, Bolívar and Loja.

It has been demonstrated that altitude physical training allows developing competition abilities in the coastal region (10,11); however it cannot be applied on inexperienced personnel. In the case of the Navy staff, this “experience” feature is not inclusive, since they already have a well developed general ability and resistance, due to the action and familiarization of the staff in the recruitment periods and permanence in the institution.

The atmospheric/climatic conditions of the altitude with influence in the physical performance are (12,13):

1. Barometric pressure: This characteristic causes that at a higher altitude the oxygen pressure of the blood diminishes (hypoxia) due to the reduction of the partial oxygen pressure of the air. (14)

[1] Biogeographic Chocó. Geographic region located northwest of South America.

2. Temperature: as the altitude diminishes the temperature increases in an average of 1°C per 150m (14) (15), however in the Ecuador's latitude it rises per 225m.

3. Relative humidity of the air: the water vapour increases as the altitude and the barometric pressure diminishes.

4. Radiation: In an altitude it increases 2% to 4% every 100m until 200m, and in 1% over that height

5. Gravity: the gravity force is inversely proportional to the distance to the center of the Earth, that is to say it diminishes with altitude.

6. Air resistance: It increases when the barometric pressure increases.

In the development of the present research paper, the referred conditions should be controlled during the process.

In the following chart are shown the main meteorological conditions of Ecuador where navy units exist.

Table 1*: Meteorological conditions of Ecuador where navy units exist.*

Region	**Altitude classification** (12)	**Maximum temperature** (16)	**Relative humidity** (16)
Coast: Guayas Esmeraldas, Manabí, El Oro, Santa Elena	Low altitude (until 1000m)	24°C a 32°C	50% a 80%
Sierra: Pichincha	High altitude (until 5550m)	16°C a 26°C	40% a 85%
Amazon: Sucumbíos, Orellana	Low altitude (until 450m)	24°C a 33°C	50% a 80%

The physical fitness is the basis of physical qualities, which are displayed as indispensable motor skills for every sport (17). The basis of these skills: strength, speed, resistance, coordination and flexibility are the specific content of the physical training of both an athlete and a soldier (18,19)

The physical aptitude corresponds to a group of anatomic and physiologic qualities subjects develop to do a physical activity in an efficient way. This development of planned activities leads to improve the neuro-muscular system and increase the tension of the muscles enhancing the reaction time; that is to say, powering up the individual (20,21).

The physical tests of Ecuador's Navy are performed taking into account charts set for age groups (1-12 groups) registered from June 1-September 1 of every year,

aimed at the whole staff without exceptions of gender and ranks and with the previous presentation of the medical record that endorses the pertinence of the evaluation.

In the physical tests, the race (3 200m run test) is aimed at evaluating the VO2max in the control group; it is performed in a plain ground, preferably without variations. The time used to cover the distance will be calculated and registered in charts with differences among age and gender. According to Romero (22) the determining factors of the test are strength, speed, aerobic-anaerobic resistance and force resistance, which in addition are inherent to the activities of the Navy staff, while the conditioning aspects will be flexibility, rapidity, speed and tactics and technique.

The hip flexions evaluate the strength and resistance of the abdominal muscles counting the number of correct repetitions made in 1,5 minutes, these are registered in charts according to age and gender. The conditioning directions of this test are force resistance, aerobic resistance, anaerobic resistance; and determining factors such as rapidity, explosive force, lactic anaerobic resistance, power and lactic capability.

The swimming tests determines the skill to swim and an important anaerobic component, since it includes anaerobic stress (both alactic and lactic) even medium distances (200m for charts 1-3) (23) and measures the aerobic resistance, the strength and resistance in big muscle groups; it is performed in 25m or 50m pools and is quantitatively evaluated in age and gender charts.

The rope climbing test (in uniforms) evaluates skills, agility, strength and arms resistance. The determining factors trained are speed, technical coordination, alactic power, aerobic power, and the conditioning aspects include explosive force, lactic capability, and aerobic capability. In men is evaluated 5m vertical rope and in women 3m vertical rope, relating the results in age and gender charts (24)

The goal of this paper is to compare the results of four physical tests (race, hip flexions, swimming and rope climbing) corresponding to the annual physical tests of the navy staff; analyzing and compare the performance of the subjects evaluated in the coast and the sierra in order to establish patterns to differentiate the physical tests of the heights and the plains, taking into consideration the influence of the Ecuadorian geography, which at present has not been included in the standardization of the evaluation charts.

METHODS

For this paper were used the results of the annual physical tests of the Navy staff of the first semester of 2015, taken from a database provided by the General Direction of Human Resources.

Of the database, made up by 17 000 militaries, only have been taken into account those part of Group 1 (aged 18-24 years and 11 months), Group 2 (aged 25-27 years and 11 months) Group 3 (aged 28-30 years and 11 months) which makes a total of 4 376 members including men and women of the coast and the sierra regions.

Since the environment conditions of the coast are similar to the ones in the Amazon (barometric pressure, temperature, humidity) this region was not consider for the study; in addition the amount of subjects tested in the east was too small, which would cause a bias in the research. As instruments were also included standardized charts in each discipline to take physical tests of the navy staff used from 2002 up to this date.

The study is observational, retrospective, analytic and transversal; taking in consideration the following quantitative variables: age (described in standardized charts), hip flexions (measures in numbers executed in 1,5 min.), differentiated by gender at the time to cover the distance established), rope climbing (time scores when climbing 3m and 5m in women and men respectively).

It was used the IBM SPSS 21 program as a statistical processor to analyze the quantitative and qualitative variables. For the analysis of the quantitative variables it was determined that the variations were not alike, for that reason was used the non-paired T test applying Welch's correction. For the analysis of qualitative variables were used frequency measures. To generate the graphics was used the GraphPad Prism program (box and whiskers) and Microsoft Excel 2013.

RESULTS

Of the total of 4 376 militaries, 4 159 work in the naval units of the coast and 217 in the mountains, with an average age of 25,37 and 26,97 years respectively.

The distribution of the staff by working regions defined in Graph 1, shows the results of the frequencies by age.

In Group 1 (18-24 years and 11 months) 40,20 % belongs to the coastal region and 17,10% to the mountains, showing an important difference of the percentage by regions. In group 2 (25-27 years and 11 months) the coastal regions shows 35,50% and the mountains 36,40% with now big frequency differences. For Group

3 (28-30 years and 11 months) the coastal region is represented with 24,30% and the mountain region with 46,5%, showing the same difference as Group 1 (Graph 1).

Graph 1. Staff age frequency in groups by region

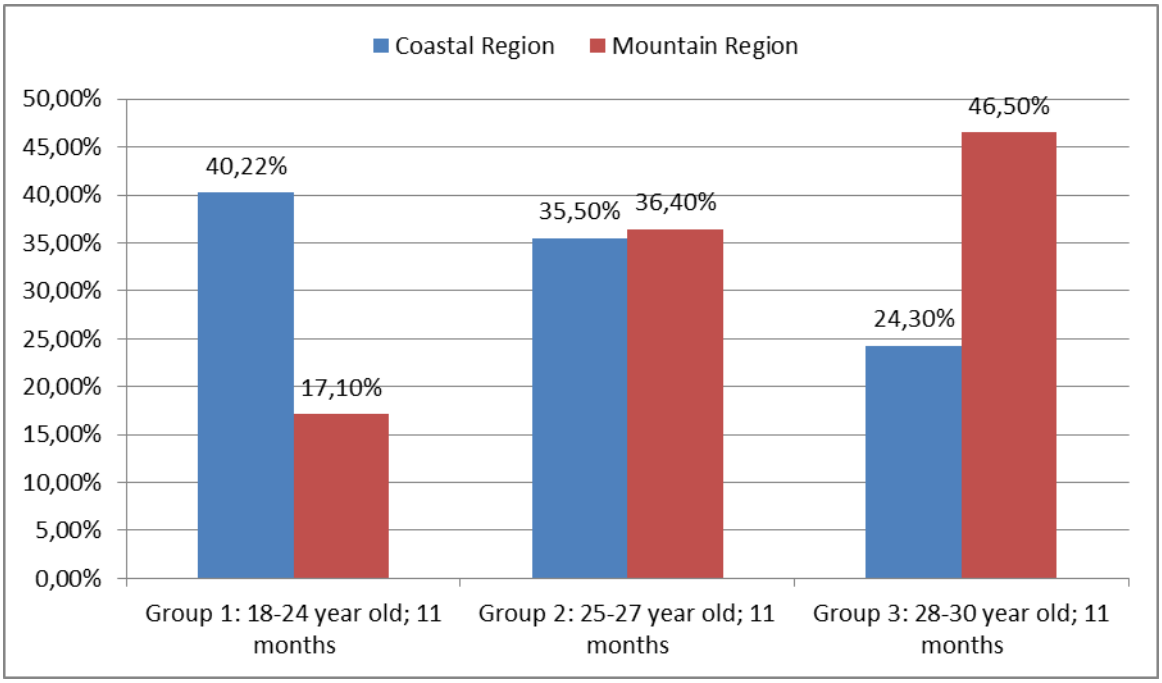


Table 2 shows the percentage of the female and male staff evaluated. In the coastal region we found that 5,40% (N=224) are women and 94,60% (N=3935) are men. In the mountain 14,70% (N=32) is female and 85,30% (N=185) male.

Table 2. *Frequency by gender and region*

Region	GENDER			
	Female		*Male*	
	N	%	N	%
Coast	224	5,40%	3935	94,60%
Sierra	32	14,70%	185	85,30%

Group 1 Staff

Group 1 was made up by individuals aged 18-24 years and 11 months tops. Table 2 shows the differences between the coast and the sierra in the male gender. Four physical tests were evaluated: Hip flexion that measures the number of flexions executed in 1,5 minutes. Swimming, which tests the time the subject takes to cover 200m in the pool. Race, that measures the time used by the subject to run 3 200 m and finally the rope climbing test, measuring the time to climb 5m.

In the men of group 1 it was observed a statistically significant difference in the hip flexion and rope climbing tests. The men of group 1 of the mountain region executed an average of 65,46 flexions compared to 63,88 of the men of the coast (p=0,0049). On the contrary, the men of the coast climbed 5 meters in 9.38 seconds and the ones of the mountain did it in 9,68 seconds (p=0,04). In the swimming and race tests was not registered any significant difference in the male Group 1 (Table 3), (Graph 2).

Table 3. Group 1 physical tests men (until 24 years and 11 months). There were registered statistically significant differences in the Hip Flexion and Rope climbing tests *p<0,049 **

Region	N	Flexion Hip (quantity)			Swimming (minutes)			Run (minutes)			Climb Cable (seconds)		
		Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value
Coast	1582	63,88	4,997	*0,050**	4,425	0,66	0,277	12,91	1,112	0,12	9,38	1,098	*0,041**
Mountain range	28	65,46	2,673		4,535	0,5168		12,65	0,852		9,68	0,723	

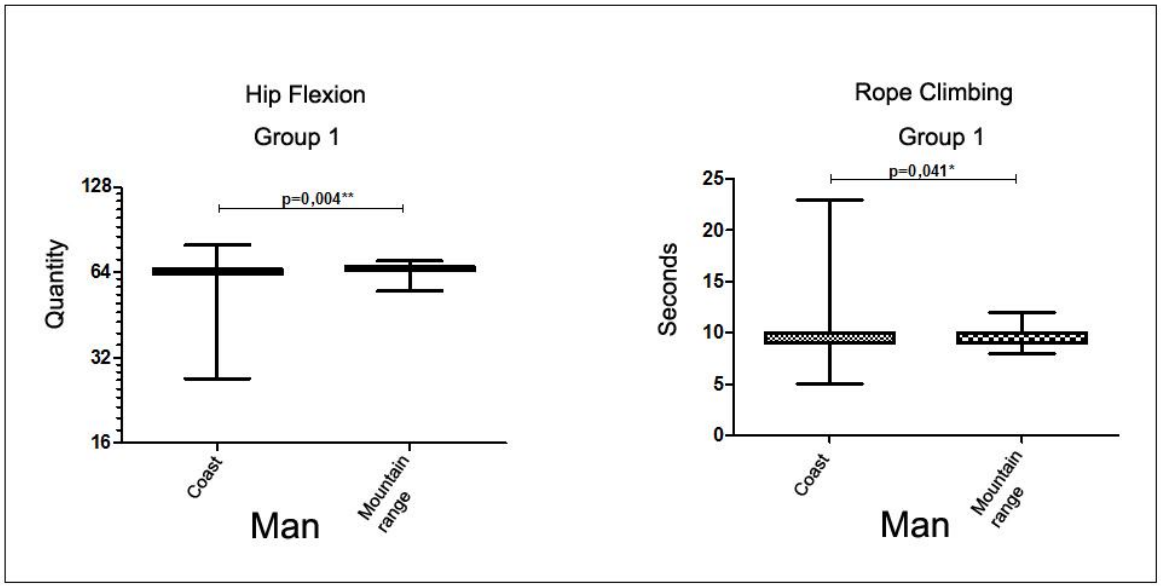
Table 4 shows the differences between the coast and the range in female militaries. Four physical tests were evaluated: Hip flexion that measures the number of flexions executed in 1,5 minutes. Swimming, which tests the time the subject takes to cover 200m in the pool. Race, that measures the time used by the subject to run 3 200 m and finally the rope climbing test, measuring the time to climb 3m.

In the women of group 1 were not registered statistically significant differences in none of the evaluated tests (Table 4).

Table 4. Group 1 physical tests women (until 24 years and 11 months).There were no significant differences in the four tests evaluated. p<0,05 *

Region	N	Hip Flexion (quantity)			Swimming (minutes)			Run (minutes)			Rope Climbing (seconds)		
		Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value	DS	T-test p-Value	DS
Coast	88	56,67	5,139	**0,562**	5,346	0,907	**0,46**	15,182	1,218	**0,244**	12,16	2,537	**0,813**
Mountain range	9	57,33	2,915		5,611	0,99		14,89	0,61		12	1,803	

Graph 2. Physical tests Group 1 Men (until 24 years and 11 months). There were statistically significant differences in the two tests evaluated p<0,004 ** in hip flexions and p<0,041 * in rope climbing.



Group 2 Staff

Group 2 was made up by militaries aged 25-27 years and 11 months. Table 5 shows differences between the coast and the sierra in the male gender.

In the men of group 2 was registered a statistically significant difference in the hip flexion and rope climbing tests. The men of group two of the mountain executed an average of 62,72 flexions compared to 63,63 of the ones of the coast (p=0,025). Likewise, the men of the mountain climbed 5 meters in 8,36 seconds and the ones of the coast in 9,41 seconds (p=0,041). In the swimming and race tests there was no significant difference in the Group 2 of men (Table 5) (Graph 3).

Table 5. Physical tests Group 2. Men (until 27 years and 11 months) p<0,05 *

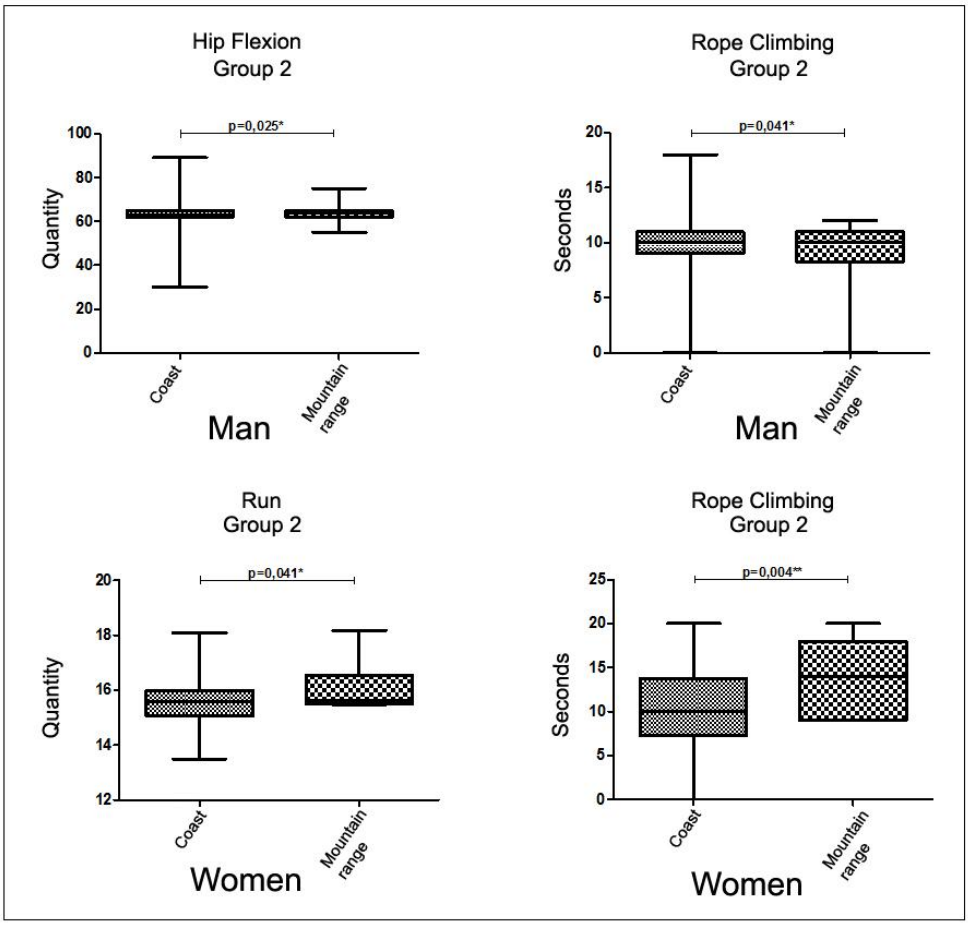
Region	N	Hip Flexion (quantity)			Swimming (minutes)			Run (minutes)			Rope Climbing (seconds)		
		Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value
Coast	1394	62,72	4,14	***0,025****	4,49	0,68	0,527	13,27	1,153	0,121	9,41	3,12	***0,041****
Mountain range	64	63,63	3,042		4,54	0,6181		13,08	0,927		8,36	3,997	

In the case of the women of group 2 there were statistically significant differences in the Race and Rope climbing tests. The women of the coast covered 3 200m in an average time of 15,53 minutes, while women of the mountains did it in 16,02 minutes (p= 0,04), (Graph 3). Likewise, the women of the coast climbed 3 meters in 9,73 seconds and the women of the mountain did it in 13, 8 seconds (p=0,004), (Graph 3). In the hip flexion and swimming tests was not registered any significant difference in the women of Group 2 (Table 6).

Table 6. Physical tests group 2. Women (until 27 years and 11 months). p<0,05 *

Region	N	Hip Flexion (quantity)			Swimming (minutes)			Run (minutes)			Rope Climbing (seconds)		
		Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value
Coast	84	54,63	5,501	0,328	5,472	0,954	0,698	15,533	0,895	***0,041****	9,73	5,906	***0,004***
Mountain range	15	55,87	4,19		5,391	0,69		16,027	0,794		13,8	4,229	

Graph 3. Physical tests group 2.Men and Women (25-17 years and 11 months). There were found significant differences in the three tests evaluated. In men: p<0,02 * for hip flexions and p<0,041 * for rope climbing. In women: p<0,041* for race and p<0,004** for rope climbing.



Group 3 Staff

Group 3 was made up by a staff members aged 28-30 years and 11 months.

In the men of Group 3 was found a significant difference in the hip flexion test. The men of group 3 of the mountain executed an average of 60,63 flexions compared to 59,89 of the ones of the coast (p=0,016), (Graph 4). In the swimming, race and rope climbing tests was not registered any significant difference in the men of group 3 (Table 7).

Table 7. Physical tests Group 3. Men (until 30 years and 11 months) p<0,05 *

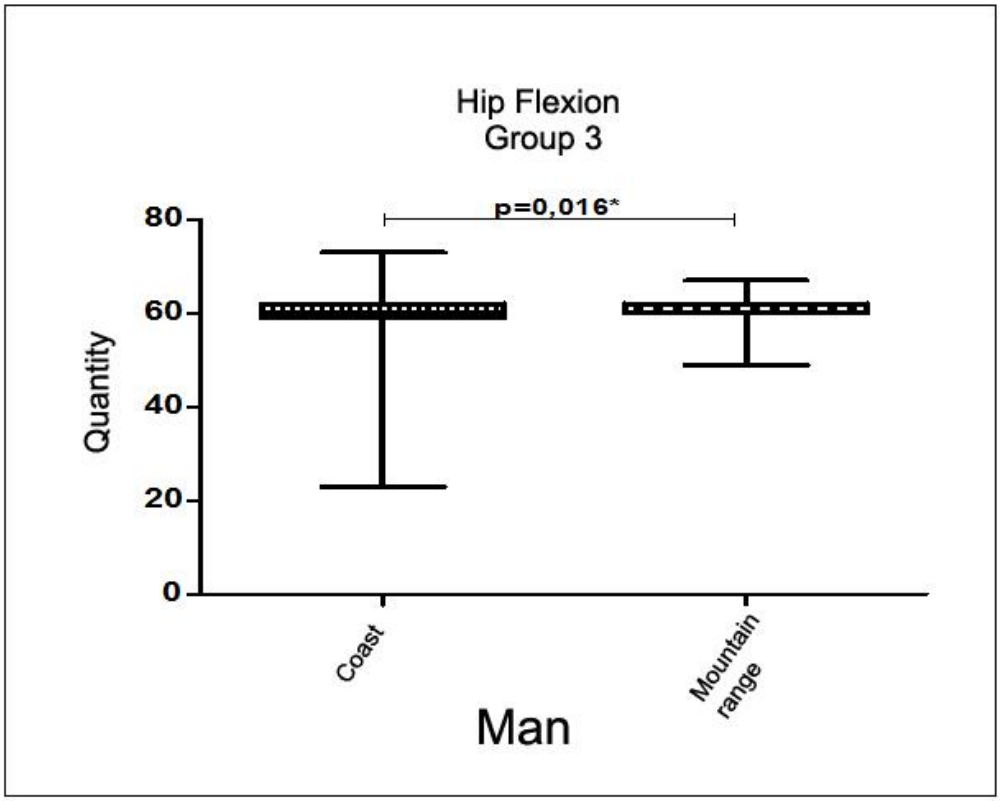
Region	N	Hip Flexion (quantity)			Swimming (minutes)			Run (minutes)			Rope Climbing (seconds)		
		Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value
Coast	959	59,89	4,434	***0,016****	4,52	0,719	0,996	13,65	1,161	0,308	9,86	3,816	0,11
Mountain range	93	60,63	2,628		4,519	0,544		13,55	0,886		9,13	4,207	

In the women of group 3 were no registered significant differences in any of the tests evaluated (Table 8).

Table 8. Physical tests, group 3. Women (until 30 years and 11 months) p<0,05 *

Region	N	Hip Flexion (quantity)			Swimming (minutes)			Run (minutes)			Rope Climbing (seconds)		
		Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value	Average	DS	T-test p-Value
Coast	52	52,08	4,053	0,102	5,682	0,975	0,081	16,263	1,165	0,34	11,92	6,945	0,802
Mountain range	8	56,25	6,182		5,112	0,747		16,079	0,288		12,63	7,21	

Graph 4. Physical tests, group 3. Men (28-30 years and 11 months). There were significant differences in the hip flexion test p<0,016*.



DISCUSSION

The results of this paper revealed important observations in regard to the instrument that evaluated the performance of the military staff in the mid-term physical tests.

The numbers difference of the subjects of the coast (N= 4159) and the sierra (N=217) divided in age groups: Group 1 (18-24 years and 11 months), group 2 (25-27 years and 11 months), and Group 3 (28-30 years and 11 months) represented a very high difference of evaluated militaries. For the present paper the N (variable) could not be controlled due to the nature of the distribution of the staff of the two regions. However, for the statistical analysis was used the T test to determine whether there are significant differences among groups; this test evaluates the mean of each group, which does not largely affect the difference of the number of subjects among the compared groups. (25)

The physical tests applied on the Navy staff were performed after six months permanence in their units, that is to say there was a period of “stable habituation” before the evaluations. (26)

In the results of the men of Group 1 here were shown significant differences in the hip flexion test, which reported an improvement of the personal performance of the militaries of the mountain in comparison to the ones of the coast (Table 3), (Graph 2). This could be due to a better physical adaptation for this kind of test in the mountain region.

In the case of the rope climbing test, in Group 1 there was a better performance in the coast; that is to say, the strength, speed, alactic capability, coordination and technique, which are determining aspects of the test, ere higher in this region, with a significant difference (Table 2), (Graph 2), which might be due to a better weekly training in the coast.

The women of Group 1 registered no significant differences in the tests; however it is important to note that the time of the race for the coast and the mountain is not recommended for this assessment, since in the two regions the time of the evaluated militaries surpasses 14,5 min, the maximum time to pass the test successfully. This might be due to the inadequate physical training in the naval units, or that the referential scale charts do not match the actual physical conditions of the women; a reason for which this aspect would require another type of study.

The results of the men of Group 2 showed significant differences for hip flexion and rope climbing (Graph 3), which include determining aspects of strength, speed, coordination and technique; showing a favourable performance of the militaries evaluated in the mountain region, which is related to what was found in Group 1 (Graph 3), since the strength exercises are not affected by hypoxia, and there was an indistinctive better performance in the two regions. In the women of this group was observed a better performance in the race and in the rope climbing of the militaries of the coast. In the race, the weaken performance of the mountain subjects would be caused by that fact that despite the habituation, in an altitude the performance diminishes 6% in regard to the sea level (27), besides this significant difference in the race matches the statements of other research papers (28), since the fact of training and living in altitudes does not bring more benefits than training in plains.

In the women of group 2 were registered significant differences in the rope climbing (Graph 3), in addition it is important to point out that the average time to climb the 3m rope in the coast is 9,41 seconds and in the mountain 8,36 seconds, outstanding results in regard to the times recorded in the standards for this age group (20 seconds), this casts serious doubts on the validity of these charts to measure physical tests.

In the men of Group 3 were found no significant differences for the hip flexions favourable for the mountain region, because since it is a test of strength and speed, is not affected by hypoxia and depends on the quality of the training in this region, an aspect evident in the three age groups of men (Graph 4). In the women of this group were not registered significant differences in any test, that is to say, the physical training is similar in both regions.

In any of the groups were registered significant differences in the swimming tests, but the performance time is over the parameters established for the maximum score; that is to say, men should be between 5,5 and 5,83 minutes and women between 7 and 7,33 minutes, and the actual values of the study were 4,48 and 4,52 minutes for men and for women 5,39 and 5,47 minutes.

This difference is explained by the specific training in naval skills inherent to Ecuador's Navy in the periods of formation, training and improvement.

CONCLUSIONS

1) When comparing the significant differences of the groups of men and women in rope climbing, hip flexion and race, the performance in altitudes and plains is not influenced by environmental factors (barometric pressure, temperature, humidity); it rather responds to the difference of the physical training in the regions. Those environmental factors were not defining due to the stable habituation (over 90 days) of the Navy staff for their permanence in the working posts.

2) The swimming tests registered no significant differences in the performance of the militaries form the coast and the mountain in the age and gender groups; not only due to the habituation period but also in the specific formation of the naval skills of the members of the Navy, for which the swimming evaluation parameters should be reconsidered.

3) This paper could detect that certain groups of evaluated women showed disaccording results in the institutionally standardized charts for the physical tests performance (career and rope climbing); that is to say they are not in tune with the actual physical capability of the group evaluated, therefore, this might be the purpose of a new research in order to establish new parameters.

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