THE AMPHIBIOUS ASSAULT:
HOW FIT ARE OUR MARINES FOR THE MISSION?

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

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B.A., University of Nevada, Las Vegas, 1977

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This study investigates the use of the Marine Corps Physical Fitness Test (PFT) in relation to the Corps' primary mission of amphibious operations. The idea discussed is that while the PFT is assumed to be an adequate measure of general fitness, it bears little relation to the tasks expected of Marines operating in an amphibious environment. In the study, a model of an amphibious operation coupled with additional research resulted in construction of a taxonomy of physical tasks common to amphibious operations. Sample PFT scores were then compared to representative taxonomy event scores to discern statistical relationships. The results of the study explain that although the PFT may be an effective measure of fitness, it fails to adequately replicate some tasks found in the taxonomy. Extrapolation of this evidence suggests that the PFT may not adequately test the kinds of physical activities present in amphibious operations. The study indicates that exclusive reliance on the PFT to ensure that Marines are physically prepared for amphibious operations may not be appropriate.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE AMPHIBIOUS ASSAULT: HOW FIT ARE OUR MARINES FOR THE MISSION? by Maj. John E. McLean II, USMC, 121 pages.

This study investigates the use of the Marine Corps Physical Fitness Test (PFT) in relation to the Corps' primary mission of amphibious operations. The idea discussed is that while the PFT is assumed to be an adequate measure of general fitness, it bears little relation to the tasks expected of Marines operating in an amphibious environment.

In the study, a model of an amphibious operation coupled with additional research resulted in construction of a taxonomy of physical tasks common to amphibious operations. Sample PFT scores were then compared to representative taxonomy event scores to discern statistical relationships.

The results of the study explain that although the PFT may be an effective measure of fitness, it fails to adequately replicate some tasks found in the taxonomy. Extrapolation of this evidence suggests that the PFT may not adequately test the kinds of physical activities present in amphibious operations. The study indicates that exclusive reliance on the PFT to ensure that Marines are physically prepared for amphibious operations may not be appropriate.

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INTRODUCTION

The casualties suffered by U.S. Marines during the amphibious assault on Tarawa during World War II stunned the American public.[1] Although the landing on 20 November 1943 was successful, it had an associated cost of more than 3,300 Marine casualties.[2]

Tarawa was the test bed of the modern amphibious landing, but none of the associated equipment received as much testing as the individual Marines of the landing force.[3] At Tarawa, it was the competence, fighting ability and physical prowess of individual Marines that made the assault successful.[4] Will the Marines of the 1990s be fit enough to provide that same vital difference during the next "Tarawa?"

Background

The effectiveness of the personnel participating in amphibious operations hinges on the type and quality of the training they receive before the assault. This study will examine the Marine Corps physical fitness test (PFT), identify the physical demands associated with amphibious operations, and assess the ability of the PFT to serve as the only compulsory physical fitness prerequisite to participation in amphibious operations.

The experience gained from the Pacific "island hopping" campaign validated amphibious doctrine and forced its permanent inclusion in the repertoire of the Marine Corps. Amphibious operations correspond favorably to the primary mission of the Marine Corps which is ". . . service with the fleet in the seizure and defense of advanced naval bases and for the conduct of such land operations as may be essential to the prosecution of a naval campaign."[5]

Since the 1940s, the Marine Corps has constantly improved its amphibious doctrine. One notable change has been the arrival of "over-the-horizon" (OTH) amphibious operations. Already in limited use in the Marine Corps, the OTH approach enhances the element of surprise in favor of the landing force but increases the distance the surface assault force must travel over water to reach the shore.[6] Such doctrinal improvements will increase a Marine's chances for surviving the physical rigors of the amphibious landing.[7]

Military practitioners consider amphibious operations to be an extremely complex form of warfare.[8] Lessons from many amphibious assaults corroborate that assertion. Those lessons cover the spectrum of natural, mechanical, and human factors.

The U.S. Army's assaults on Omaha and Utah Beaches at Normandy on 6 June 1944 confirmed the difficulties involved with amphibious operations. For the soldier, the combination of enemy fire, obstacle emplacements, combat loads, and deep water caused drowning to become a constant danger on D-Day.[9] In the harried days of World War II, men were quickly trained then rushed into combat.

Today, the Marine Corps is America's premiere amphibious force.[10] Readiness and training have become its hallmarks. Because of ample funding and long periods of peace, training shortcomings cannot be used as excuses for future oversights that result in wasteful losses of personnel.

Has that training been thorough enough to prevent needless personnel losses during the next real-world application of amphibious doctrine? The survival of our young Marines hangs in the balance. They will be the first to cross the beach on future "Tarawas," "Normandys," or "Inchons."

Significance of the Study

The importance of this study cannot be underestimated. The Marine Corps prides itself on its institutional physical fitness. Much time and effort are spent on maintaining those high physical standards. Yet, if the test being used does not prepare a Marine for the physical demands of amphibious operations, the value of that investment of time and effort may be debatable.

The political status of the former Warsaw Pact nations is drastically different than during the Cold War. Because of the resultant "peace dividend," the Department of Defense is reducing its budget and minimizing forward deployed, land-based forces. Because of these changed political realities, it is likely that the U.S. will continue to rely heavily on its ability to project maritime power.

A key element of maritime power projection is the presence of Marine forces. Their amphibious capability signals to a potential aggressor that a U.S. naval deterrent force has at its disposal land, sea, and air forces ready to deter that aggression. In April 1991, the Secretary of the Navy (SECNAV), the Chief of Naval Operations (CNO), and the Commandant of the Marine Corps (CMC) jointly wrote an article that discussed the future efforts of the Naval Service. They said that foremost among Navy-Marine Corps operations would be power projection, deployment flexibility, and surge capability. Power projection was included since ". . . it is the key to successful implementation of a stability strategy."[11]

The material readiness of our Navy-Marine Corps team is arguably at its highest point in history. But what is the level of physical conditioning of the Marines who will represent that key element in maritime power projection?

The present emphasis on physical fitness in the United States may have improved the general physical well being of at least some of our citizens. Combined with that awareness, the Marine Corps PFT does a credible job of ensuring that our Marines are physically fit.[12] But does the resultant level of fitness provide Marines with a solid foundation for participating in amphibious operations? Does that test, the single physical fitness measurement tool in use by the Marine Corps, test the types of physical tasks expected to be encountered during amphibious operations?

In an address given on 2 August 1990, President Bush said that future U.S. defense policy would be based on deterrence, forward presence, crisis response, and force reconstitution.[13] Added to this policy, the joint comments of the SECNAV, CNO, and CMC, coupled with the changing world situation, make it likely that Marine amphibious forces will be called upon to represent U.S. interests in future crises. The necessity of those forces to possess an effective amphibious capability is brought into sharp focus when one considers that most of the earth's population resides within fifty miles of a sea coast.[14]

As a service chief, CMC must ensure that the organization, training, and equipment of the Marine Corps are responsive to its contingency missions. Exhaustive studies are routinely conducted to perfect the organizational aspect of that responsibility. Similarly, before new equipment is purchased, it undergoes a great deal of analysis to assure its suitability for the intended purpose.

The PFT serves that purpose where personnel are involved. In contrast to the staff work and scientific analysis involved with the organization and equipment of the Marine Corps, one can only assume that the PFT measures the type of physical fitness necessary for successful participation in amphibious operations. This study examines a small aspect of that apparent shortcoming, and will attempt to determine whether absolute reliance on the PFT is justified.

If that test measures the right kind of fitness, our Marines are safe and our amphibious capabilities are assured. If it does not, our Marines may suffer needlessly and our ability to project forces ashore may be compromised. Writing about the physical aspects of amphibious operations, S. L. A. Marshall identified a shortcoming of the U.S. Army's World War II experience at Omaha beach. He said that "The fundamental error was a simple one. We overestimated the physical strength of men in the conditions of combat."[15] This study stresses that military readiness must include the human physical element which deserves no less scientific analysis than the organizational and equipment elements.

The Research Question

The central question to this research is "Do the tasks measured by the Marine Corps physical fitness test adequately assess the fitness needs of Marines in an amphibious assault? " Subordinate questions strive to establish a comparison of PFT events and physical tasks performed during amphibious operations, identify shortfalls in the current PFT in terms of events or repetitions performed and, isolate the events that best replicate physical tasks common to amphibious landings.

The assumptions for this study were:

a. That a direct comparison of the PFT and the physical tasks associated with amphibious operations is feasible.

b. That the average Marine is eighteen years of age, is 70.2 inches tall, and weighs 144.8 pounds.[16]

c. That the loads borne by individual Marines are within the normative range of thirty to 45 percent of body weight.[17]

d. That the PFT achieves its stated purpose of measuring physical fitness.

e. That the obstacle course and swimming qualification tests are responsive to the needs of Marines involved in amphibious operations.

The following definitions clarify the terms used in this study:

a. Amphibious Assault - an amphibious operation ". . . that involves establishing a force on a hostile shore."[18]

b. Amphibious Operation - "An attack launched from the sea by naval and landing forces, embarked in ships or craft involving a landing on a hostile shore."[19]

c. PFT - Physical Fitness Test: a standard test given semiannually to assess a Marine's level of physical conditioning.[20]

d. Physical fitness - "the capacity of an individual to perform given physical tasks involving muscular effort." This definition implies elements such as agility, power, speed, reaction time, endurance, and strength.[21]

e. Ship-to-shore - the phase of an amphibious operation in which landing craft are launched from ships of the amphibious task force.

f. Surface assault force - that portion of the landing force that uses amphibious craft to transit from the line of departure to the beach (as opposed to the vertical force which uses aircraft for transport to the shore).

Also included are the limitations, delimitations, and variables that help focus the study.

The limitations include:

a. Study of male Marines only.

b. Study of Marines in the landing force despite their military occupational specialty differences.

c. Study considers only the assault phase of an amphibious operation and focuses on ship-to-shore movement of the landing force.

The delimitations include:

a. No consideration of combat operations occurring after the amphibious assault.

b. No consideration of forces landed after the initial assault or actions taken during the general unload period of an amphibious operation.

c. No detailed study of exercise physiology.

In summary, this study will examine the PFT, identify and evaluate the physical activities that occur during amphibious operations, and compare the resulting taxonomy of physical events with those of the PFT. The results of that comparison will determine the appropriateness of using the PFT as the only recurring physical prerequisite to participation in amphibious operations.

ENDNOTES

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[6]U.S. Marine Corps, "Over-The-Horizon (OTH) Amphibious Operations Operational Concept" (Quantico, VA: Marine Corps Combat Development Command, 15 March 1991), 4. (Cited hereafter as OTH.)

[7]T. Linn, "Over-the-Horizon Assault: The Future of the Corps," Marine Corps Gazette 71 (December 1987): 44.

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[18]Joint Chiefs of Staff, JCS Publication 1, Department of Defense Dictionary of Military and Associated Terms (Washington, D.C.: The Joint Chiefs of Staff, 1 April 1984), 27. (Cited hereafter as JCS Pub 1.)

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[20]U.S. Marine Corps, Marine Corps Order 6100.3J, Physical Fitness (Washington, D.C.: Department of the Navy, Headquarters, U.S. Marine Corps, 1988), 1. (Cited hereafter as MCO 6100.3J.)

[21]MCO 6100.3J, 2.

CHAPTER 2

LITERATURE REVIEW

A review of available literature helped explore the feasibility of the study, and isolate related material. In structuring the review, it was necessary to divide the study into its two primary components: the Marine Corps Physical Fitness Test (PFT), and amphibious operations. Sub-elements of the primary categories include amphibious operations and associated physical considerations, physical training, and literature related to load bearing capabilities.

PFT-Related Works

The initial review revealed a wealth of information related to the PFT. To ensure that the data considered was relevant to the study, a selection criterion was necessary.

Information concerning the PFT had to relate to the test itself or to its individual events. Studies about the use of the PFT as a predictor of combat readiness were especially important. The review included studies that compared the PFT to combat scenarios other than amphibious operations, but only to the point where extrapolation of the information presented could be applied to this study. Related literature included load bearing, swimming, and aerobic and anaerobic conditioning techniques to improve combat readiness.

No material was used that related the PFT to health improvements, physical appearance, advancement, or better mental hygiene. Information of this genre was readily available; however, the intent of such information falls outside the scope of this study.

Chief among the literature concerning the Marine Corps PFT are Marine Corps Orders (MCO) in the 6100.3-series. Additionally, a 1980 presidential request for information about physical readiness in the military served as the catalyst for many studies of military fitness conducted during that decade.[1] Many of those studies were reviewed for this research.

The history of physical fitness in the Marine Corps can be traced through the editions of the 6100.3- orders. Other evidence dates the first interest in Marine Corps physical fitness testing to 1 October 1875.[2]

MCO 6100.3 established the first institutionalized PFT for the Marine Corps in 1956.[3] The original test consisted of eight events. Pullups, straight leg situps, and a reduced-distance run were included as parts of that test.[4]

The PFT has often been studied by students of Marine Corps service schools. A study conducted in 1962 conveyed the idea that physical fitness testing will not improve fitness; rather, it is a measurement of existing physical condition.[5]

MCO 6100.3F, Physical Fitness and Weight Control, was published in 1971. That order directed the first Marine Corps-wide use of the current PFT. The test consisted of pullups, bent knee situps, and a three-mile run.[6]

P. Davis, A. Curtis, and S. Bixby conducted a study in 1981 to find the physical performance tasks required of Marines operating in a desert environment. An introductory remark effectively summarized the empirical background of the PFT when the researchers said

> This test has been in existence for nine years and represents a fitness battery consisting of items whose capability of predicting combat readiness has not been scientifically validated.[7]

Another study conducted by Dr. Davis, A. Curtis, and T. Bachinski in 1982 provided information about the physical tasks that challenge Marines in a high altitude, cold weather environment. A statement in that study identified the reason the Marine Corps uses only one physical fitness test for its personnel. The authors wrote that

> . . . the Corps believes that every marine is fundamentally a rifleman, and as such, only a single minimum set of standards needs to be developed for the entire Corps.[8]

In 1984, the U.S. Army commissioned a study to compare aerobic power and dynamic lift capacity with sustained combat-related performance. That study, conducted by W. Daniels and F. Drews, concluded that the (Army) PFT results of their subjects failed to correlate well with field performance.[9]

Dr. Davis, C. Dotson, and B. Sharkey undertook another study for the Marine Corps in 1986. In that endeavor, the researchers arrived at several conclusions that appear to militate against the 1984 study by Daniels and Drews. Included in those conclusions were that:

a. the level of fitness in the Marine Corps was "responsive" for its mission;

b. PFT results provide the Marine commander with a "reasonable estimate" of combat readiness; and,

c. there was no testing or training, other than the PFT, which could "evaluate the combat readiness of any individual Marine."[10]

A sub element of the 1986 study by Davis, et al. was a synopsis of physical activities that may occur during amphibious operations. The authors classified the physical demands of Marines embarked aboard ship (not in the ship-to-shore phase of an amphibious assault) as "lifting, pulling, and pushing such objects as jeeps, gun carriages and cases of C-rations."[11]

To accomplish their study, Dr. Davis and his team developed a taxonomy of physical tasks through which they could assess physical conditioning. Included in that list were several items that related directly to amphibious operations. Those tasks included swimming, wading, climbing ladders, ropes, and trees, and negotiating obstacles.[12]

A related statement in the same study shed more light on the physical demands of amphibious operations. The authors were impressed when Marines in full combat gear climbed down cargo nets from a supply ship into their landing craft. The operation took place at night in fifteen to twenty foot sea swells. Dr. Davis' team concluded that significant upper body strength and coordination were required to complete the embarkation of the landing craft without mishap. Interestingly, the researchers said there were more frequent demands for muscular strength and power during amphibious operations than the aerobic requirements they had observed in cold weather and desert operations.[13]

Kennedy said in August 1986 that the muscles used while performing pullups varied with the grip on the bar. Gripping the bar with the palms toward the body primarily taxes the biceps, while performing the exercise with the palms facing away from the body used the deltoid and latissimus dorsi muscles. The author further stated that taxation of the abdominal muscles occurred while performing situps.[14]

MCO 6100.3J, Physical Fitness, is the tenth and most recent order in the Marine Corps physical fitness series. That directive specifies the events to be tested in the current Marine Corps PFT. That test consists of an untimed pullup exercise, a two-minute bent-knee situp exercise and a timed three-mile run.[15]

Besides identifying the events of the test, MCO 6100.3J also defines the performance categories and regulates the frequency and conditions for administration of the PFT.[16] According to the order, the express intent of the test is to measure physical fitness.[17] Although PFT scoring cannot be adjusted for age, classification of physical fitness is divided into three age groups. Categorization of physical fitness achievement is based on the total PFT score attained during the test. The classification matrix appears at figure 2-1. MCO 6100.3J further classifies first class attainment by saying that Marines who attain a score of 285 or higher possess a superior level of physical performance.[18] A Marine who fails to attain a minimum passing score (per figure 2-1) or cannot pass any individual event, despite the cumulative score, fails the entire test.

	Age	Age	Age
Classification	17-26	27-39	40-45
1st Class	225-300	200-300	175-300
2nd Class	175-224	150-199	125-174
3rd Class	135-174	110-149	85-173
Unsatisfactory	0-134	0-109	0- 84

Figure 2-1. Performance Classification

PFT scores are derived based on individual performance in each event. A Marine who does 20 or more pullups, 80 or more situps, and attains a run time of 18:00 or less will achieve the maximum score of 300 points. Using the raw score conversion method published in the order, a Marine who does 17 pullups, 75 situps, and attains a run time of 19:30 will achieve a score of 266 points. The scoring chart at figure 2-2 displays the score-point conversion table.

Dr. Davis wrote an article with C. Dotson in 1988 concerning the relationship between the PFT and combat performance. The authors prefaced their article by citing a 1981 Department of Defense study that said the goal of military fitness programs and research was to make military members as fit as possible for combat operations.[19] The authors wrote that the PFT adequately tested general physical fitness.[20] Their study also showed that a direct relationship existed between the PFT and combat tasks.[21]

The basis for the article is the 1986 study by Davis et al. on the fitness requirements of Marines possessing military occupational specialty 0311 (basic infantryman), cited earlier in this chapter. The methodology used in that research centered on the use of a criterion task test (CTT) from which the physical performance of two battalions of Marines was judged.

Pts	PU	SU	Run	Pts	PU	SU	Run	Pts	PU	SU	Run
100	20	80	18:00	66		63	23:40	32		32	29:20
99			18:10	65	13		23:50	31		31	29:30
98		79	18:20	64		62	24:00	30	6	30	29:40
97			18:30	63			24:10	29		29	29:50
96		78	18:40	62		61	24:20	28		28	30:00
95	19		18:50	61			24:30	27		27	30:10
94		77	19:00	60	12	60	24:40	26		26	30:20
93			19:10	59		59	24:50	25	5	25	30:30
92		76	19:20	58		58	25:00	24		24	30:40
91			19:30	57		57	25:10	23		23	30:50
90	18	75	19:40	56		56	25:20	22		22	31:00
89			19:50	55	11	55	25:30	21		21	31:10
88		74	20:00	54		54	25:40	20	4	20	31:20
87			20:10	53		53	25:50	19		19	31:30
86		73	20:20	52		52	26:00	18		18	31:40
85	17		20:30	51		51	26:10	17		17	31:50
84		72	20:40	50	10	50	26:20	16		16	32:00
83			20:50	49		49	26:30	15	3	15	32:10
82		71	21:00	48		48	26:40	14		14	32:20
81			21:10	47		47	26:50	13		13	32:30
80	16	70	21:20	46		46	27:00	12		12	32:40
79			21:30	45	9	45	27:10	11		11	32:50
78		69	21:40	44		44	27:20	10	2	10	33:00
77			21:50	43		43	27:30	9		9	33:10
76		68	22:00	42		42	27:40	8		8	33:20
75	15		22:10	41		41	27:50	7		7	33:30
74		67	22:20	40	8	40	28:00	6		6	33:40
73			22:30	39		39	28:10	5	1	5	33:50
72		66	22:40	38		38	28:20	4		4	34:00
71			22:50	37		37	28:30	3		3	34:30
70	14	65	23:00	36		36	28:40	2		2	35:00
69			23:10	35	7	35	28:50	1		1	36:00
68		64	23:20	34		34	29:00				
67			23:30	33		33	29:10				

Figure 2-2. PFT Scoring Table

(Pts denotes points attained, PU is the raw score column for pullups, SU is the raw score column for situps, and Run is the raw score column for run time.)

In that study, the researchers assembled two groups of approximately twenty Marines each of which represented "expert" panels used to identify the CTT. These Marines were selected primarily because they were combat veterans. The Delphi technique was used to derive the criterion tasks after a series of task statements and responses. The researchers followed this procedure with the application of simple statistics (median and range) to validate the selection of CTT.[22]

The CTT had direct application to Marine Corps operations in high altitude-cold weather (HA/CW) conditions although the Delphi session identified tasks that encompassed amphibious, jungle, HA/CW, and desert warfare.[23] The HA/CW CTT taxonomy consisted of six events. These included a measured march while wearing vapor barrier boots, a measured snowshoe pack course, a measured ahkio (a team-pulled device used for transporting and storing equipment in a HA/CW environment) pull course, digging a defensive position, and executing a simulated emergency resupply sprint of fifty meters while carrying two 45 pound water containers.[24]

The performance of the test populations in the CTT was compared statistically to their performance on an "enhanced" PFT. This PFT was augmented by three events. These included a long jump, maximum pullups while wearing a standard ALICE pack containing a twenty-five-pound plate, and a 150 meter hill dash at a six percent grade.[25]

The results of the research led the authors to conclude that the PFT "has been shown to be a valid predictor of performance in this environment." They also stated, however, that

> Extrapolations may be made to other combat theaters only through speculation; however, the arduous nature of sustained activity in a HA/CW environment is bound to have a high degree of transferance [sic] to other locales.[26]

These statements provide the basis for those made by the authors in their Marine Corps Gazette article. Other statements in that article tended to be much more general especially as they pertained to the direct relationship between the PFT and combat tasks. In reality, the "enhanced" PFT was the measurement device, and the authors qualified their statement of the predictive qualities of the PFT by saying that "The PFT can be used, as a reasonable first screen for determination of combat readiness before deployment to a cold weather theater of operations."[27]

The most significant conclusions of this research were those that pertained subsequent studies. The authors recommended the adoption of standardized combat tasks that could be used to determine individual combat readiness. Additionally, the authors warned against making inferences about the predictive quality of the PFT to "unrelated activities such as swimming."[28] This research proved invaluable to the present study.

In 1989, T. Rupinski completed a study involving Marine Corps recruits and physical fitness. The study primarily considers the effect of height and weight on PFT performance. For the research, Rupinski selected a test population of 113,332 males.[29] Of that population, 72.8 percent placed in the first class category of the PFT.[30] Rupinski also found that the Marine Corps PFT had a greater relative difficulty than the tests of other U.S. Services.[31]

The Rupinski study was important since it identified another method for comparing PFT events to manual tasks. The paper established a positive correlation between box carrying and lifting power with situps, pullups and the three-mile run.[32]

The research showed that higher performances in these exercises correlated well with box carrying power. Running proved to be the most reliable predictor of carrying capacity. Pushups or pullups, as tests of upper body strength, proved to be the best predictors of lifting capacity.[33]

Although pushups are not part of the Marine Corps PFT, they are mentioned in the study since Rupinski concluded that a high correlation coefficient (.82) existed between pushups and pullups. It was Rupinski's opinion that, for the PFT, pushups could be substituted for pullups without changing the meaning of the test. He based his statement on the high correlation between the two exercises.[34]

The intent of the study was to quantify the relationship of height and weight on PFT performance. After conducting a regression analysis, Rupinski concluded that PFT scores decreased as body mass or weight increased.[35]

Summary

Literature about the Marine Corps PFT shows that test to be the only one of its kind in use by the Marine Corps. Marines must take the PFT twice annually. It consists of three events that measure aerobic (cardiovascular) fitness, upper body, and abdominal strength. The current test has been in use since 1971. Although there have been some initiatives to alter the test, publication of MCO 6100.3J in 1988 left the PFT unchanged.

The purpose of the PFT is to test fitness. Designers of the test did not intend for it to replace all other types of physical activity. Throughout the Marine Corps, physical conditioning programs include events such as conditioning runs, conditioning marches, forced marches, and runs of the obstacle course.

Publications such as MCO 6100.3J and Fleet Marine Force Reference Publication 0-1B Marine Physical Readiness Training for Combat stress the need for balanced physical training programs. Additionally, both publications advocate frequent, progressive, and demanding conditioning programs to ensure individual readiness for combat.

The PFT contains no events that assess the ability to swim or float. Programs such as combat water survival, afford Marines a one-time opportunity for intensive water safety and survival instruction. Current Marine Corps directives do not specify an annual requirement to test swimming, floating, or drown proofing techniques. Marines need not prove their aquatic skills before their assignment to a unit that will become part of an amphibious ready group.

Studies have concluded, however, that the level of fitness in the Marine Corps, measured periodically by the PFT, is responsive to its mission. Also, researchers have shown that the PFT provides a reasonable estimate of combat readiness. Since the PFT is most often administered at the small unit level, individual commanders should be well aware of the specific levels of fitness of their Marines.

Works Related to Amphibious Operations

Literature selection for this category was based on two criteria: (1) that it provided information on the conduct of amphibious operations; and, (2) that it provided information on the physical requirements related to amphibious operations. There is an abundance of literature on amphibious operations.

Marshall referred to the inherent dangers facing soldiers during amphibious operations. Notable is his statement concerning the high number of soldiers killed during the amphibious assault of Omaha Beach during World War II.[36] Although he was unable to distinguish between the number of soldiers killed by drowning and those who drown because of wounds from enemy fire, excess cargo weight and composition played a key adverse role.[37] Marshall also cited an inaccurate assumption made by military planners of the time concerning their estimates of general soldier strength in combat conditions.[38]

Isley and Crowl described Marine Corps amphibious experiences during World War II. Their account of the amphibious assault on the Gilbert Island of Tarawa in November 1943 cites many valuable lessons. Also, it provides insights into the hazards wrought by the prepared defense of a shore. Tarawa served well as a case study because of its ground-breaking use of modern technology, and command and control techniques.[39]

Among the execution-related lessons is the necessity to assess accurately the waterborne approaches to the beach.[40] If done incorrectly, landing craft will be forced to discharge their Marines prematurely, thus requiring them to wade or swim ashore under enemy fire. Despite the approaches selected at Tarawa, many Marines were forced to take the same action after their landing craft received disabling enemy fire.[41]

The authors also mentioned that obstacles presented a major concern during the assault on Tarawa. Obstacle negotiation and reduction operations, conducted under enemy fire, resulted in many casualties.[42]

Heinl identified some physical stresses that confronted Marines during the amphibious assault at Inchon, Korea in September 1950. During that assault, Marines disembarked from their landing craft onto mud flats separated from the beach by a stone seawall.[43] The seawall had to be breached using scaling ladders and cargo nets before the landing force could be established ashore. A news reporter accompanying the Marines in the assault said the seawall looked "as high as the RCA building."[44] This example shows one type of obstacle that can effectively impede the progress of assaulting Marines.

Hertling discussed amphibious operations in an incidental fashion. He said that a soldier assigned to a unit likely to encounter water obstacles must be able to swim or a "leadership casualty" will probably result.[45]

Preparations for amphibious operations, technological and physical, must continue to ensure success. Available literature also gives some insight into the equipment presently used for amphibious operations. Darling highlighted the capabilities of the Landing Craft, Air Cushion (LCAC), in use with U.S. Naval amphibious forces.

The LCAC represents the first generation of landing craft faster than the ships that make up the amphibious task force. The craft has a range of two hundred nautical miles and allows the surface assault to be launched from up to forty miles offshore. This increased standoff distance translates to a greater chance of survival for the landing force.[46]

Because of the improved ride characteristics of the LCAC, troop endurance on the water may be increased from the traditional one hour in a conventional landing craft. Additionally, the LCAC affords reduced vulnerability, relative freedom from natural obstacles and tidal effects, and greater survivability against mines and indirect fire weapons.[47] The LCAC represents a significant advancement in amphibious warfare technology.

There is also some literary speculation on evolving doctrine for amphibious operations. Linn stated in his article that over-the-horizon (OTH) amphibious assaults are the future of the Marine Corps.[48] Because of the LCAC, OTH operations will increase the survivability of the landing force. This also means, however, that the surface assault force must cover a greater distance over water before reaching the shoreline.[49] As that distance increases, it becomes increasingly important that Marines possess adequate physical capabilities, especially in the area of water safety and survival.

Earl wrote that because of improved enemy capabilities, ships of the amphibious task force can no longer steam to within sight of the beach before launching their landing craft. Because of OTH, there is a substantial increase in the area available to amphibious attack. As a result, an enemy defender must accept a less cohesive and effective defense over a greater area.[50] Earl also provided effective descriptions of amphibious operations in the past (World War II), present (nonOTH), present (OTH), and future (OTH).[51]

Marine Corps doctrine states several reasons for conducting amphibious assaults. Among them are: projecting U.S. influence onto a hostile shore, obtaining sites for naval or air bases, denial of the use of an area or facility to an enemy, prosecuting subsequent combat operations, and aiding in the restoration of a friendly government.[52]

Given the state of technology during World War II, only seventeen percent of the world's littoral zones were subject to amphibious assault. Because of the level of technological development, exemplified by the LCAC, approximately seventy percent of the world's shoreline can be assaulted by an amphibious force.[53] Given the breadth of uses for amphibious operations and the global susceptibility to attack from the sea, amphibious operations should continue to be a viable method of forced entry.

A recent Marine Corps concept paper concerning OTH amphibious operations says twenty-five miles from the shore is the minimum launch distance. That distance is possible because of advanced technology landing craft (LCAC) to support the surface assault force, and improved technology aircraft to support the vertical force.[54]

The paper also outlined some major threats facing an amphibious landing force. Whatever the present political state of the former Soviet Union, the single greatest threat to a landing force is a joint, combined arms defender using doctrinal Soviet-style tactics. Such forces would be composed of land, sea and air forces operating in and around the amphibious objective area.[55] The paper described current anti-landing doctrine as enemy engagement of the amphibious force at extreme ranges, extraordinarily dense fires in the beachhead area, and extensive use of obstacles, barriers, and mines.[56]

Continuing its discussion of threats, the OTH concept paper said that the most vulnerable element in the assault is the ship-to-shore phase.[57] The surface assault force can expect to encounter mines in the surf, on the beach, and in the surrounding shallow water.[58]

Summary

Most of the literature related to amphibious operations proved to be very useful. It provided valuable insight into the physical rigors that confront Marines participating in amphibious operations. S. L. A. Marshall cited some hazards associated with the heavy loads carried by soldiers engaged in an amphibious operation.

The historical treatise on Tarawa reflected a need for swimming or wading capabilities while participating in an amphibious assault. The obstacles that confronted the

Marines attacking Tarawa, also challenged the Marines who assaulted Inchon. The number of obstacles on a defended shore showed the need for members of the landing force to possess adequate upper body strength and coordination.

The taxonomy of physical tasks developed to test the physical fitness of Marine infantrymen proved very useful for this study. Swimming, wading, climbing trees, ladders, and ropes, and negotiating obstacles are tasks that can be directly applied to amphibious operations. Of particular importance was the conclusion of one team of researchers who, after assessing the physical requirements of high altitude/cold weather and desert operations, said that amphibious operations had high demands for muscular strength and power.

Improved technology for landing craft such as the LCAC led to the formulation of the OTH approach. Arguably, the concept will lead to greater elements of surprise and survival in behalf of the landing force. Yet launching the surface assault force from a distance exceeding twenty-five miles from the shore assumes that the water survival skills of the Marines in the landing force are in peak condition.

Doctrine does not direct the exclusive use of OTH during amphibious operations. For example, against an unprepared or less sophisticated enemy, conventional (nonOTH) methods can be used. OTH is simply one of many options. Given the developmental level of OTH doctrine, however, one can assume that amphibious warfare experts will be anxious to display the capabilities of this innovative technique.

Based on present technology, seventy percent of the earth's littoral zones are now susceptible to amphibious assault. Because of the many uses of amphibious operations, their short-notice employment may continue to be frequently directed by the national command authority as opposed to other, less readily available means.

Miscellaneous Literature

Related literature was also available that did not fit into the two preceding categories. These writings were notable since they dealt with subjects such as physical requirements in amphibious operations, physical training, and load bearing.

Physical Requirements for Amphibious Operations

McCleskey wrote that more than 7,000 Americans drown every year. Sixty percent of those resulted directly from accidental entry into the water.[59] His article argued for implementation of a balanced aquatic program for the Marine Corps.

In an article about physical fitness and combat readiness, Ryan wrote that increased upper body strength is necessary for Marines. He advocated that routine physical training also should include climbing ropes and dry (cargo) nets to build that strength. Ryan stated further that building upper body strength could be accomplished by regularly performing exercises such as dips, bent knee situps, pushups, pullups, and rope climbs.[60]

Sfayer and Hertling said that space restrictions aboard amphibious ships have sometimes led commanders to replace physical training with simpler endeavors, or delete it entirely during the cruise. Suspending all physical activity would be extremely detrimental if a long movement phase was part of an amphibious assault. Stopping physical training or greatly reducing its frequency leads to what fitness researchers term the detraining effect.

Detraining implies that the same type of muscle atrophy and cardiovascular sluggishness found in patients who undergo prolonged bed rest can occur to otherwise healthy subjects when their physical activity is stopped. NASA researchers explored detraining as early as 1962 when astronauts, after short orbital space flights, encountered similar problems. They dubbed the effect cabin atrophy.[61]

Aina wrote that Marines must now pass a new water survival test. Termed the "Combat Water Survival" (CWS) test, new accessions into the Marine Corps learn to use their combat equipment as flotation aids. Successful completion of the test is the achievement of a CWS-3 rating.[62] Upon further review, CWS has not yet been implemented by a Marine Corps order.[63]

The director of the U.S. Marine Corps Troop Training School at Landing Force Training Command, Pacific, wrote a letter that described some physical challenges Marines encounter during amphibious training. During amphibious refresher training, Marines negotiate an obstacle course and dry nets. Both events test and enhance upper body strength. Further, they are fundamental prerequisites for amphibious operations. In closing, the director said that the opinion of the school was that upper body strength, endurance, and "relative" aquatic skills were important in the ship-to-shore phase of an amphibious operation.[64]

Summary

Thousands of people die annually in the United States from accidental entry into the water. An extreme example of accidental entry could be a combat loaded Marine descending a cargo net from an amphibious ship to an awaiting landing craft. Negotiating such nets over a distance of twenty to thirty feet is challenging. Executing the same feat in sea swells of fifteen to twenty feet, at night, is still more difficult. Combat water survival training is a step in the right direction. However, CWS is not yet part of the official Marine Corps training regimen.

Marines may lose their edge physically if commanders curtail physical training during the movement phase of an amphibious operation because of space limitations. The absence of that conditioning, even during a short period, may make the difference between absolute and questionable combat readiness.

Marines who are responsible for conducting amphibious training submit that the most demanding portion of an amphibious operation is the ship-to-shore phase. They identify the need for upper body strength and endurance as a prerequisite to successful participation in that phase. Obstacle courses and dry net training represent training aids used to develop those qualities.

No swimming skills are taught in courses that train Marines in the more "routine" aspects of amphibious operations. School officials nonetheless recommend that all Marines possess some aquatic skills based on the tasks they must perform in their units.

Physical Training Considerations

In 1960, Svenson wrote an article that addressed the physical needs of Marines. He addressed the need for improved and continued physical training during the movement phase.[65]

Murphy et al. conducted a study that compared anaerobic power capacity to sustained operations. They concluded their research by saying that soldiers with greater anaerobic power capacity can sprint faster and move more quickly than those with a lower capacity. Such capabilities may enhance the performance of infantry-related tasks.[66]

The Marine Corps is often compared to the light infantry of the U.S. Army in terms of relative mobility. Drews completed a study of the physical requirements for soldiers serving in light infantry units. After soldiers participating in the test completed a five-day exercise, Drews concluded that aerobic power was the leading parameter of fitness attainment.[67]

An important element in the Drews study was that during the exercise, soldiers exhibited a decline in muscular endurance power. This was evident in the upper body (arms and shoulders) but not in the legs. The research asserted that the cause may be unequal training emphasis in the upper and lower torso. He made the observation based on the soldiers' reduced ability to bear their forty-two pound loads during the five-day exercise.[68]

Summary

This literature acknowledged that physical training must be conducted above and beyond the level of conditioning runs. To be effective in combat, a Marine must have the physical strength to succeed. Physical training must encompass upper body development exercises in the correct proportion to aerobic capacity.

A Marine in combat does not perform the PFT. Instead, he bears his load over long periods of time, and in a variety of conditions. He also must locate, close with, and destroy the enemy by fire and close combat. Those elements, in essence, are what a task-specific PFT should test.

Literature Related to Load Bearing

The final subclassification to be considered was literature relating to the load bearing capabilities of Marines and soldiers. Several of those studies were relevant to this research.

Fenton described the nominal load carried by Marines. That load consists of sleeping bag, field jacket and liner, NBC protective mask, helmet, waterproof bag, wet weather suit, long johns, suspender straps, shelter half, tent pins and poles, entrenching tool, web belt, poncho with liner, watch cap, 2 canteens, canteen cup, first aid kit, 2 M-16 ammunition pouches, gloves, flak jacket, and the ALICE pack with frame. This list does not include other items such as extra utilities, socks, underwear, shaving gear, sleeping mat, other personal effects, weapons, ammunition, and MREs.[69] Although a dated article, this average load composition remains generally current.

Inghram wrote about the need to reduce the combat load carried by Marines. Citing a U.S. Army study, he wrote that the ideal load represented 30 percent of the soldier's weight or approximately forty-eight pounds. The maximum load should not exceed 45 percent of the soldier's weight or about seventy-two pounds.[70]

Knapik conducted a study that reviewed the physical aspects of military load bearing. The weights and percentages that appeared in Inghram's article were corroborated by this study. Those weights amounted to thirty percent of body weight or 48.4 pounds for a combat load, and forty-five percent of body weight or 72.6 pounds for an approach march load.[71] The study considered the average U.S. Army Infantryman to be one hundred seventy-three centimeters (68.1 inches) tall, weighing seventy-three kilograms (160.6 pounds).[72]

Knapik said that the primary physiological factors involved with load bearing were muscle endurance and aerobic capacity. Upper body muscle groups were not a primary element of the study. The research recommended that jogging, resistance training and interval training be used to improve load bearing abilities in soldiers.[73]

Summary

Marines participating in amphibious operations must carry combat loads in the forty-eight to seventy-two pound range. Current policy in many Marine Corps units requires that Marines carry such loads during regularly scheduled conditioning marches.

Marines involved in amphibious operations also must carry loads in this nominal range during ship to shore movement. The literature stressed that loads borne by Marines should be carefully planned by the commander based on his estimate of the situation. Close attention must be paid to constructing a training schedule capable of preparing Marines to bear combat loads.

Conclusion

Vital aspects of this study reference the research material considered during this review. The literature is generally available through the Defense Technical Information Center and Headquarters, U.S. Marine Corps. An examination of this material will provide another researcher a useful point of departure for replicating or amending this study.

While MCO 6100.3J, Physical Fitness, publishes the regulations for physical fitness testing in the Marine Corps, the order itself does not attempt to be all encompassing. It cautions Marines that total reliance on mastery of the PFT events "can be detrimental to the training required to develop the 'total Marine.'"[74] Rather than such mastery, the order states that the "goal of the physical fitness training program is the success of Marines in combat."[75]

The studies comparing the PFT to combat performance represent attempts to quantify the usefulness of that test and project its capabilities. Although this study examined only a few of those references, they all generally conclude that the PFT adequately achieves the goal stated in MCO 6100.3J, Physical Fitness. In so concluding, the researchers sampled have not provided an alternative to the current test consisting of pullups, situps, and the three-mile run.

The research revealed no direct link between the PFT and combat-related tasks. Several studies have recommended that further research be conducted to derive a test directed toward individually assessing a Marine's physical conditioning for combat. Based on the literature reviewed for this study, no research has been conducted to compare PFT performance with the physical tasks inherent in amphibious operations.

The works pertaining to amphibious operations show many inherent hazards. These include: the amphibious assault of a defended beach (enemy fires and obstacles); water depth and sea state; and, combat loads borne by assaulting Marines. Advances in technology have ameliorated some of those hazards. The LCAC will move Marines ashore faster than older landing craft thus reducing their exposure to enemy fire. The ability of the LCAC to negotiate obstacles up to four feet in height may also reduce the effects of enemy emplaced antilanding obstacles.

Improvements in technology may help reduce the individual Marine's susceptibility to the hazards of water and enemy obstacles. Should an LCAC itself become a casualty during its twenty-five mile run to the beach, the embarked Marines will either be alive because of their water survival skills or dead because of the lack of that training. Technology has not relieved Marines of the necessity to be able to do the physical tasks associated with amphibious operations.

The body of research suggests the need for Marines to bear significant loads during combat operations. When the physical demands of amphibious operations are compounded with the requirement to bear 50 to 70 pound individual loads, a Marine's chances for survival may be reduced. Marshall wrote that heavy loads contributed to many U.S. drownings at Normandy in World War II. Bearing the weight of current combat loads while negotiating obstacles may further, dangerously tax the physical capabilities of a Marine.

In general, the available sources suggested that there is still much research to be done in the area of quantifying the physical performance of Marines. This research is a step in that direction. It is important since the prevalent attitude among previous researchers has apparently been that the PFT itself must be considered a constant. While certain considerations must be made when designing a PFT such as equipment requirements, ease of administration, and the time consumed by the test, those should not be the only elements considered. Exercises that compare favorably with representative combat tasks should be identified and incorporated into any new test design.

Beyond formally recognizing some of those combat tasks, the resultant PFT would ensure that Marines are challenged by a test that conveys real world significance.

ENDNOTES

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[18]Ibid., Enclosure 1, D-1.

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[22]0311, 15.

[23]The Davis et al. research that related to amphibious operations was unavailable through DTIC or through Dr. Davis' office since it is no longer in print.

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CHAPTER 3

RESEARCH DESIGN

Associating the events found in the Marine Corps PFT with the physical activities that occur during amphibious operations required a sequential approach. Initially, the PFT events were examined to learn major muscle group involvement and determine a method of comparison. Much of that information was gathered during the literature review.

Next, identification of the physical activities that occur most frequently during amphibious operations took place. These activities were identified through a review of available research material and by use of a model amphibious operation.

The tasks identified by the model were then compared to the tasks identified during the literature review. Tasks common to both sources were then compared to the PFT.

To accomplish this comparison, continuous PFT, swim qualification, and obstacle course scores were obtained from The Basic School, Marine Corps Combat Development Command, Quantico, Virginia. The population was drawn from Company E, class 5-91, and consisted of one hundred forty-seven sets of scores. The scores were standardized and entered into a database format.

Statistical analysis, specifically the Pearson-moment correlation, was performed using Kwikstat statistical analysis software developed for IBM and compatible microcomputers.[1] The Pearson-moment correlation using a five-by-five matrix was recommended by Wayne H. Osness, Ph.D., the Chair of the Education Committee for the United States Olympic Committee. Dr. Osness based his recommendation on the size of the population and the fact that continuous scores were available for events that appeared to be comparable.[2] The methodology flow chart is found at figure 3-1.

Physical Events of the Marine Corps PFT

As was mentioned previously, the PFT consists of three events: pullups, situps, and a three-mile run. These three events are designed to test separate elements of physical conditioning. For example, the pullup exercise challenges the pulling and lifting strength of the upper body through exertion of the biceps and latissimus dorsi.[3] The situp exercise primarily tests the rectus abdominus (abdominal muscles) and iliopsoas (hip flexors).[4] Finally, the three-mile run is used as an indicator of general cardiovascular functioning.[5] Figure 3-2 illustrates the muscle group involvement by PFT event.

Research Methodology Steps

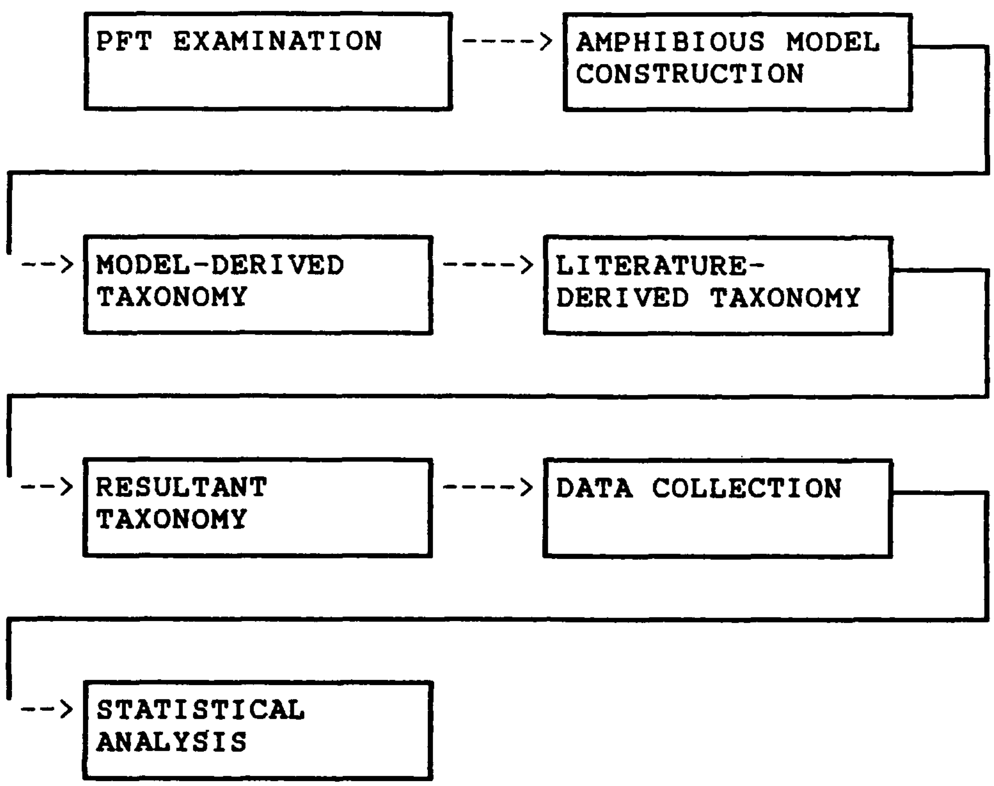


Figure 3-1. Research Methodology

Event	Muscle Groups Involved
Pullups	Biceps; latissimus dorsi; deltoids (grip dependent)
Situps	Rectus abdominus; iliopsoas
3-mile run	Quadriceps (primarily measures cardiovascular (aerobic) capacity)

Figure 3-2. PFT Events and Muscle Groups Involved

Amphibious Operation Model

Background. Present amphibious doctrine endorses and practices the over-the-horizon assault (OTH).[6] Such assaults are undertaken when maximum surprise is necessary and against a sophisticated and capable enemy. Launched at distances exceeding twenty-five miles, OTH assaults evade radar and visual detection until just before the landing force arrives ashore.[7]

In instances where the opposing force is less capable or sophisticated, the near shore assault is still used. The difference in technology between the two types of assaults is the reliance of the OTH assault on air transport of the landing force.[8] The model constructed for this study is generic and does not require specification of OTH or nonOTH doctrine and techniques.

The Amphibious Task Force (ATF). For the purpose of this model, the ATF will be a standing, afloat unit as opposed to a contingency force. The ATF consists of Navy and Marine elements. For this model, it is built around a four-ship "mix." This ATF includes an "Iwo Jima" class LPH, a "Charleston" class LKA, a "Whidbey Island" class LSD, and a "Newport" class LST. Such a mix normally supports a Marine Expeditionary Unit (MEU) which consists of the traditional elements of a Marine Air-Ground Task Force (MAGTF).

In this model, the landing force is a MEU comprised of about 4,000 Marines. MAGTFs of this type habitually serve as amphibious ready groups in the Western Pacific and Mediterranean regions. The normal duration for these cruises is six months. MEU sub units include the command element, the ground combat element (GCE; made up of a battalion landing team), the air combat element (ACE; consisting of a composite squadron of various aircraft types), and the combat service support element (known as a MEU service support group (MSSG)).[9]

The LPH is an amphibious assault ship that serves the MEU as a base for aviation operations. It carries the preponderance of the ACE and some elements of the GCE or MSSG. The LKA is an amphibious cargo ship, normally reserved for the MSSG. The GCE is "combat loaded" aboard the LSD (dock landing ship) and the LST (tank landing ship). Portions of the ACE and MSSG, however, are often embarked on these ships as well.[10]

The LSD is the only ship in this ATF that can support LCAC operations. Additionally, as opposed to the other ships in the ATF, the LKA has no well deck. As a result, its landing craft cannot be loaded and launched from within the ship. Landing craft from the LKA are lifted by crane into the water or provided by another ship of the ATF, and Marines embark the awaiting craft by negotiating ladders or cargo nets.

Landing craft of the ATF are composed of several types. The LSD has a complement of four LCACs.[11] Utility landing craft (LCU) can transport troops and heavy equipment. Large and small mechanized landing craft (LCM-8 and LCM-6) also transport troops and equipment.[12] Marine Corps assault amphibian vehicles transport combat ready Marines to the beach.[13] Finally, Marine Corps light armored vehicles are also capable of amphibious landings.

Sequence of Events. Amphibious operations occur in five general phases: planning, embarkation, rehearsal, movement, and assault (PERMA).[14] This method of organizing the events that make up those operations has been in use since World War II. PERMA will help illustrate the tasks involved in an amphibious assault as they occur.

Planning. This phase of the amphibious operation begins upon receipt of the initiating directive from a higher headquarters.[15] Actions during this phase normally involve planners at the highest echelons of command. Planning an amphibious operation is arduous because the high degree of coordination required to achieve the close timing tolerances required for the assault.[16]

Analysis of Physical Effort. This phase of the operation usually takes place in the headquarters of the units involved with the operation. It is largely administrative in nature requiring great deals of mental activity over a short but sustained period. There are no repetitive physical tasks during the planning phase.

Embarkation. Embarkation of the landing force begins when planners agree on a concept for the operation. During this phase, personnel and equipment of the landing force assemble at the port and are loaded aboard ships of the ATF.[17] Positioning of personnel and their equipment aboard the ships is critical and must be conducted in reverse order since the items needed at the onset of the assault must be the most easily accessible.

Analysis of Physical Effort. Lifting, pushing, and pulling typify the tasks required during embarkation. Marines work individually and in teams in the close spaces of the ship throughout this phase. Embarkation is usually an around-the-clock operation until the job is complete. This consideration suggests an endurance requirement beyond upper body strength.

Rehearsal. The rehearsal phase of an amphibious operation tests the planned tactical landing.[18] Besides familiarizing members of the ATF with the tactical plan, the rehearsal also checks the combat readiness of participating forces.[19] Rehearsals may be actual, requiring the landing of the landing force on a benign shore, or it may be constructive using wargaming methods.

Analysis of Physical Effort. When wargaming techniques are used to rehearse the landing plan, there are no express physical requirements. If an actual landing is used to rehearse the plan, the physical tasks are roughly identical with those in the assault phase. As a result, those tasks will be identified during examination of the assault phase itself.

Movement. In this phase, the ATF is underway to the amphibious objective area (AOA).[20] The duration of the movement phase is variable. It is dependent on the distance from the port of embarkation to the AOA, and the relative speed of the ships in the ATF. During the recent crisis in the Gulf, cargo ships leaving the west coast of the United States required a thirty to forty day steaming time.

Analysis of Physical Effort. The physical factors involved with the movement phase are negligible. Daily activities include weapons cleaning, small unit training, requisite shipboard duties (such as cleaning living spaces and serving as galley attendants), and physical training. Despite the space limitations aboard the ships of the ATF, physical training must be conducted regularly to avoid the effects of detraining.[21] Therefore, individual commanders control the physical tasks associated with the movement phase.

Assault. The assault phase of an amphibious operation begins when the ATF arrives in the AOA. It ends upon accomplishment of the mission specified by the initiating directive. A traditional indicator of near-term mission accomplishment is acknowledgement by the commander of the landing force that the force beachhead is secure and the landing force is firmly established ashore.[22]

The landing force itself consists of two elements: the surface assault force and the vertical force. The vertical assault force represents a tactical grouping of Marines transported ashore via helicopters. The surface assault force reaches the shore aboard landing craft of the types mentioned previously. Employment of these two types of forces is dependent on the concept of the operation. For this model, concentration is placed on the surface assault force.

Landing craft of the surface assault force launch according to a strict time schedule. Movement of the landing craft away from the ships of the ATF represents commencement of the ship-to-shore (STS) phase of the assault. Loading the landing craft takes place before STS and often during the embarkation phase. Load maintenance and shifting may be conducted before the assault.

Landing craft are launched from the well decks of the ships in the ATF. At the time they are launched, loads are complete and the Marines who make up the boat teams for the landing craft are embarked. Each Marine carries personal equipment within the normative weight ranges stated in chapter two. Aboard the LKA, landing craft loaded with supplies are lowered into the water by the ship's cranes or come along side the ship after being previously launched from another assault ship of the amphibious task force. Combat loaded Marines embark the landing craft over the side of the ship using cargo (dry) nets.

Depending on the enemy situation and the equipment available in the ATF, landing craft are launched as close to shore as 4,000 yards, or as far away as twenty-five miles or more.[23] Although landing craft have a significant range, embarked Marines can only endure a ride of approximately one hour because of factors such as wind, sea, and surf conditions. The endurance threshold for personnel embarked aboard LCACs has eclipsed that one hour period because of the greatly improved ride characteristics of that craft.[24]

As the assault craft approach the shore they may come under enemy attack. The attack may be perpetrated by land, sea, or air forces firing direct or indirect fire weapons. Mines in the shallow water, in the surf, or on the shore also impede progress during STS.[25]

The coxswains try to beach their craft as close as possible to the shore. However, the beach gradient, surrounding reefs, and sand bars affect the outcome of those attempts. The location of the beached landing craft will determine whether the embarked Marines walk, run, wade, or swim ashore.

Other landing craft such as LCACs, assault amphibians, or light armored vehicles can transition immediately from waterborne movement to land operations. Normally, Marines embarked in such vehicles do not experience significant water immersion. That generalization, however, will be influenced by the amount and type of antilanding obstacles present in the beach area, and the reliability of the individual craft or vehicle.

As the surface assault force arrives ashore, it may be faced with natural and manmade obstacles. Natural obstacles may be barrier-like reefs or extremely slight beach gradients that extend a significant distance from the shore. Either type of obstacle may force coxswains to beach their landing craft prematurely. Examples of manmade obstacles are seawalls, dikes, or specific antilanding obstacles such as wire, abatis, and minefields.

The surface assault force moves ashore in waves (increments). Waves are used to manage the influx of personnel and equipment onto the beach, and to manage landing craft availability during STS. After the initial waves have landed, emphasis will normally shift to landing urgently needed support forces and supplies. After landing the final waves, ships of the ATF beach and commence the general unloading phase. During that phase, all landing force equipment is unloaded and brought ashore.

The general unloading phase is one of the final actions taken during assault phase. Once complete, the landing force is free to prosecute subsequent combat operations ashore, or execute other orders of higher headquarters. A diagram of the assault phase appears at figure 3-3.

Analysis of Physical Effort. The assault phase is the most physically demanding of the five phases. In order of occurrence, the physical tasks involved may be as follows:

Load landing craft

Don personal equipment

Embark landing craft

(Begin dry net operations if embarked aboard LKA).

Upon arrival at the beach, the following tasks may occur:

Swim or waoe ashore if landing craft is damaged/destroyed or beaches prematurely because of reef, sand bar, or shallow gradient

Negotiate obstacles while carrying equipment

Move (march) to the beach to begin the ground assault.

Based on the model, the taxonomy of physical tasks identified during the literature review appears accurate. A synopsis of representative physical tasks by model phase appears in figure 3-4.

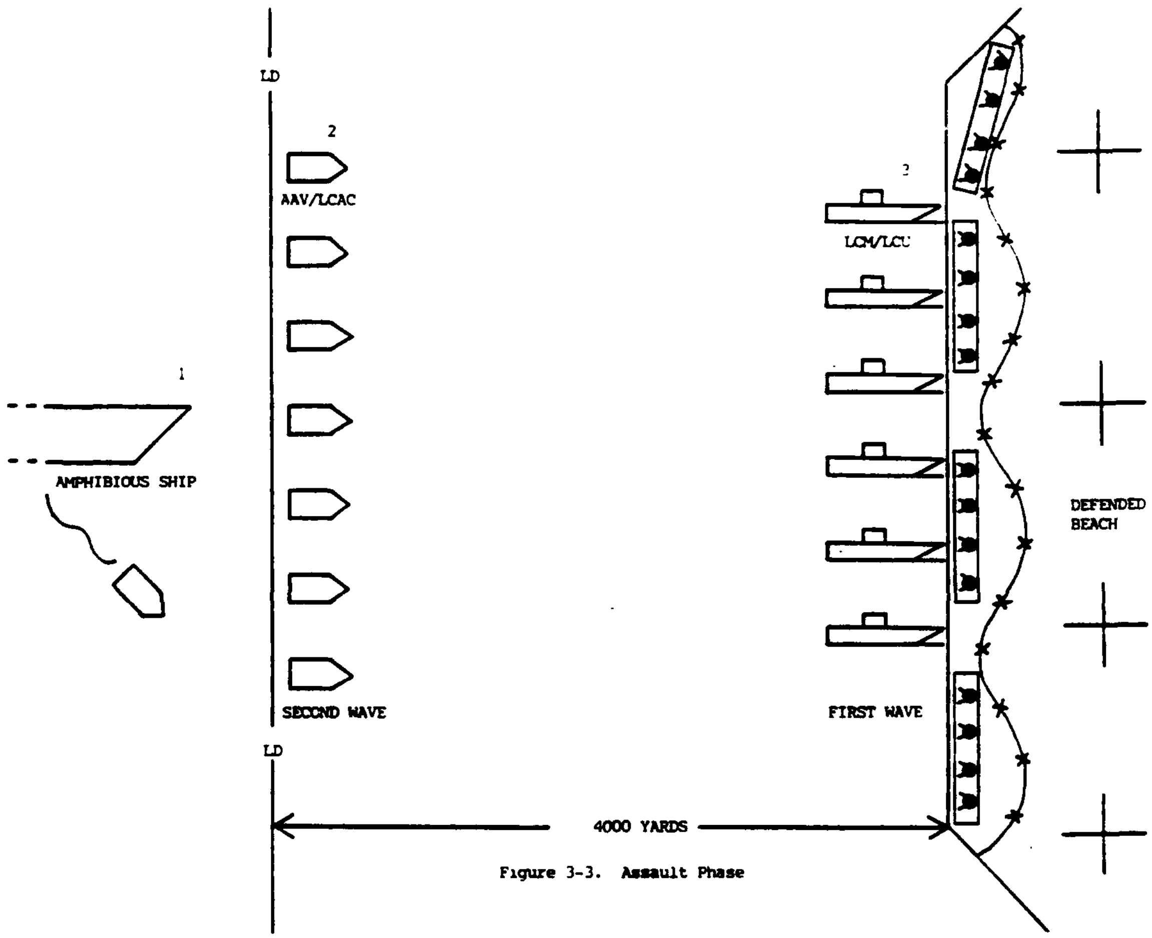


Figure 3-3. Assault Phase

Legend for Figure 3-3

1. Landing craft deploy from the supporting amphibious assault ship to the line of departure. Marines embark the craft either in the well decks of the amphibious ships or, in the case of an LKA, after negotiating dry nets.

2. Combat ready landing craft assemble just behind the line of departure to ensure the wave is properly timed and prepared for the assault. The assault commences as the landing craft cross the line of departure. It is executed in waves to achieve a constant and rapid buildup of forces ashore.

3. Landing craft arrive at the assault beach. The distance from the line of departure to the beach is about 4,000 yards. Marines debark their landing craft at the beach and assemble before beginning the ground assault. Numerous obstacles will have been emplaced by the enemy defending the beach to slow the assault and allow a heavy volume of fire to be directed into the assault force.

Amphibious Ship. Ships from which Marines embarked in their landing craft begin the assault phase.

AAV/LCAC. Assault Amphibian Vehicle or Landing Craft, Air Cushioned.

LD. Line of departure.

LCM/LCU. Landing craft, mechanized or landing craft, utility.

First wave. First portion of assault forces to arrive at the beach.

Second wave. Second (and subsequent) wave of assault forces following closely behind the first at an accurately timed interval.

Defended beach. Beach held by the enemy. Normally littered with obstacles from the deep water level (antiship mines) to the beach. Anti landing obstacles may include steel or concrete tetrahedrons or abatis, antipersonnel and antitank mines, and barbed wire or concertina. The obstacles would be covered by fire from both direct and indirect fire weapons.

Load landing craft with required equipment
Don personal equipment
Embark landing craft/begin dry net operations
Swim/wade ashore
Negotiate obstacles
Move (march) to the beach

Figure 3-4. Assault Phase Physical Tasks

In their study, Physical Fitness Requirements of United States Marine Corps MOS 0311, Davis et al. identified a taxonomy of physical tasks that typified the kinds of tasks to be encountered during amphibious operations.[26] The researchers identified the taxonomy through use of the Delphi technique, mentioned previously in chapter 2. The taxonomy appears in figure 3-5.

Paddling
Wading
Walking (unloaded)
Swimming
Climbing
Lifting, loading, unloading
Performing CPR
Marching (loaded)
Negotiating obstacles

Figure 3-5. Davis, et al. Taxonomy of Physical Tasks evident during Amphibious Operations

Three tasks that appeared in the Davis, et al. study failed to appear in the model. These were paddling, walking (unloaded), and performing cardiopulmonary resuscitation (CPR).

Paddling is interpreted as using an oar to propel a craft such as a rubber boat to the shore. There are periodic requirements for that type of activity. The necessity for paddling does not occur with the same frequency, however, as it once did. This is because of the introduction of new technology small boats such as the combat rubber raiding craft (CRRC). A fifty-five-horsepower outboard motor powers the CRRC.[27] The introduction of this craft postdated the Davis, et al. study. Because of its limited use and the introduction of craft such as the CRRC, paddling did not apply to this study.

Walking unloaded also was not deemed appropriate for this study. Unloaded walking occurs in daily life to Marines and civilians alike. That event is not peculiar to amphibious operations although it often takes place while so engaged. It was, therefore, removed from consideration.

The last event not common to both task lists was performance of CPR. As with unloaded walking, CPR is neither peculiar to nor a required ability for participating in an amphibious operation. Rather than a physical task, CPR is a voluntarily learned skill. CPR is not a physical task that will be performed by most Marines participating in an amphibious operation. By experience, a great deal of physical exertion is involved with administering CPR, and knowledge of its administration enhances any military unit. It is, however, not a prerequisite to participation in amphibious operations, and it was also not considered a critical part of the taxonomy.

The next task was to conduct a comparison between the model-derived and literature-derived physical taxonomies. The illustration of this comparison appears at figure 3-6.

Model Taxonomy	Literature Taxonomy
Load landing craft	Wading
Don equipment	Swimming
Embarkation	Climbing
Swim/wade ashore	Lifting, loading, unloading
Negotiate obstacles	Marching (loaded)
Move/march to beach	Negotiating obstacles

Figure 3-6. Model/Literature-derived Taxonomy Comparison

The two taxonomies compared very favorably with each other although there were exceptions. Loading landing craft, mentioned in the model compares favorably to lifting, loading, and unloading proposed by Davis, et al. Donning equipment did not compare well to any event in the literature-derived taxonomy. This event was probably considered implicit by the panelists assisting Davis, et al. during the Delphi sessions.

Embarkation did not compare directly with the literature taxonomy but the relationship between embarkation and climbing is unmistakable. Embarkation can occur via dry net negotiation, ladder negotiation or simply walking aboard the awaiting landing craft.

The swim/wade ashore event in the model taxonomy compared directly to those events listed individually in the literature taxonomy. Obstacle negotiation also was a direct match between the two lists. Move/march to beach compared favorably to loaded marching. Movement to the beach requires a loaded marching capability.

The model and literature-derived taxonomy comparison led to the task list used for this study. The final list of physical tasks inherent in amphibious operations appears at figure 3-7.

Lifting, loading, unloading
Climbing
Wading
Swimming
Negotiate obstacles
Loaded marching

Figure 3-7. Physical Task List for Amphibious Operations

The final step in the study was comparing the events tested in the PFT to the events in the physical task list. Marine Corps training activities at The Basic School (TBS), Quantico, Virginia, and the School of Infantry (SOI), Marine Corps Base, Camp Pendleton, California were asked to provide lists of continuous PFT scores. Swim qualification and obstacle course scores were also requested from each location. This data was used to conduct a statistical analysis of the similarity of the events.

ENDNOTES

[1]Kwikstat Version 3.01 Plus, TexaSoft, Cedar Hill, TX.

[2]Interview with Dr. Osness at the University of Kansas, Lawrence, Kansas, of 17 March 1992.

[3]U.S. Marine Corps, Fleet Marine Force Reference Publication 0-1B, Marine Physical Readiness Training for Combat (Quantico, VA: Marine Corps Combat Development Command, 1988), 7-5.

[4]Ibid., 7-5.

[5]Ibid., 7-7.

[6]U.S. Marine Corps, "Over-The-Horizon (OTH) Amphibious Operations Operational Concept" (Quantico, VA: Marine Corps Combat Development Command, 15 March 1991), 9. (Cited hereafter as OTH.)

[7]Ibid., 1.

[8]Linn, T, "Over-the-Horizon Assault: The Future of the Corps," Marine Corps Gazette 71 (December 1987): 44.

[9]U.S. Marine Corps, Amphibious Doctrine (Washington, D.C.: Marine Corps Institute Command and Staff College Nonresident Program, 1989), 55. (Cited hereafter as Doctrine.)

[10]U.S. Army, Student Text 100-1, Navy and Marine Corps (Fort Leavenworth: U.S. Army Command and General Staff College, 30 June 1991), 5-2.

[11]Ibid., 5-9.

[12]Ibid., 5-2.

[13]Ibid., 4-12.

[14]Doctrine, 12.

[15]Ibid., 12.

[16]J. Isley and P. Crowl, The U.S. Marines and Amphibious War (Princeton: Princeton University, 1951), 251.

[17]Doctrine, 13.

[18]Ibid., 13.

[19]Ibid., 13.

[20]Ibid., 13.

[21]J. Sfayer and M. Hertling, "Fit to Fight," Marine Corps Gazette 71 (August 1987): 43.

[22]Doctrine, 13.

[23]OTH, 1.

[24]M. Darling, "LCACs: Characteristics and Tactical Implications," Marine Corps Gazette 71 (December 1987): 43.

[25]OTH, 5.

[26]P. Davis, C. Dotson, and B. Sharkey, Physical Fitness Requirements of United States Marine Corps MOS 0311 (Langley Park, VA: Institute of Human Performance, February 1986), 16.

[27]Department of the Navy, Coxswain Course Program of Instruction (San Diego, CA: Landing Force Training Command, Pacific, April 1991), IV-C-8.

CHAPTER 4

ANALYSIS

The data for this study consisted of PFT, swim qualification, and obstacle course scores. The swim and obstacle course events, each of which appeared in the physical task list for amphibious operations (figure 3-7), were chosen as representative tasks since firsthand testing of every taxonomy event could not be accomplished for this research. The representative events under which taxonomy tasks were grouped appear in figure 4-1.

TAXONOMY GROUPS	REPRESENTATIVE EVENT
Lifting, loading, unloading Climbing Negotiating obstacles	Obstacle course test
Wading Swimming	Swim test
Loaded marching	None

Figure 4-1. Taxonomy Groups and Representative Events

The obstacle course event, routinely tested and practiced throughout the Marine Corps, represented one sample event. The lifting, loading, unloading, climbing, and negotiating obstacles events were grouped under the obstacle course task. Wading and swimming were grouped under the representative task of swimming. This was done because of the related aquatic nature of the two taxonomy events, and because swimming is tested in the Marine Corps. Loaded marching could not be tested since neither TBS nor SOI conducted individual assessments of conditioning march proficiency.

The combination of PFT, swim, and obstacle course scores represented the minimum data necessary to derive a statistical comparison between current Marine Corps tests and the taxonomy used in this study. A population greater than fifty (N>50) was needed to ensure the significance of the analysis.

Upon request, TBS provided the requisite scores of three student companies. The scores for Company E, 5-91 were selected since records for that company contained complete data.

SOI also attempted to provide the data requested for this study; however, none was obtained due to difficulties in electronic data transmission/reception. This was unfortunate since the overall PFT scores initially reported by that activity reflected greater variance than the TBS scores.

Examination of the data from Company E permitted establishment of a population of one hundred forty-seven

(N=147). Performance data for Women Marines and foreign officer students were removed from consideration to conform with the limitations of this study. The descriptive statistics for the population of Company E students appear at figure 4-2, and the data themselves appear at Appendix A.

EVENT	MEAN SCORE	STD. DEV.	STD. ERR.	MIN	MAX	N
Pullups (count)	20.4	2.83	.234	13	37	147
Situps (count)	80.3	5.48	.454	61	108	147
Run (minutes)	19:37	1:28	2:03	15:50	23:06	147
Swim (points)	105.61	9.127	.755	85	115	147
O-Course (minutes)	01:08	0:10	0	0:46	01:42	147

Figure 4-2. Raw Data Statistics

The scores were presented to Dr. Wayne H. Osness, professor of exercise physiology at the University of Kansas, and Chair of the Education Committee of the United States Olympic Committee. After reviewing this study and the scores, Dr. Osness recommended construction of a five-by-five matrix of correlations to determine the relationship between the events.

Upon initial analysis of the data, it appeared that the scores of the population were skewed to maximum performance in all events. While such achievement is laudable and suggests high levels of physical fitness, the data required normalization to allow a more accurate comparison.

Scores for pullups, situps, and the swim test were decremented by percentages from the population highs of 37, 108, and 115 respectively, then converted to decimal equivalents. Data for the two timed events, run and obstacle course, were converted to hundredths of an hour, then decremented from the fastest event times of 15:50 and 0:46 respectively. The resultant normalized scores appear at Appendix B. The 5X5 matrix of correlations was performed on the normalized data and appears at figure 4-3. Histograms for each of the PFT and test events appear at Appendix C. As was mentioned previously, all statistical analyses were accomplished using KwikStat statistical data analysis software.

Interpretation of the analysis followed traditional lines. Given that a perfect correlation would have a coefficient of ±1, the subordinate correlations are strong (.8 to .99), moderate (.6 to .79), slight (.4 to .59), weak (.2 to .39) and very weak (.1 to .19).

The matrix suggested a correlation between performance of the three PFT events. Those correlations, between pullups and situps, pullups and the run, and situps and the run, are displayed in bold print. These positive

	PFT EVENTS			TEST EVENTS	
	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
PULLUPS		0.617	0.432	0.205[3]	0.349[1]
SITUPS			0.493	0.123	0.206[2]
RUN				0.067	0.162
SWIM					0.155
O-COURSE					

Figure 4-3. Matrix of Correlations

relationships generally indicated that as the performance level of one event (such as pullups) increased, performance could also be expected to increase in either of the other two events (situps and run). The most significant correlation is between pullups and situps (moderate), while the remaining two combinations reflect slight correlations.

Some interpretation of those results is necessary to obtain a clear illustration of the relationships. Above all, the events of the PFT are all related to conditioning. Pullups, situps, and the run are practiced with great regularity in the Marine Corps, and each Marine has developed an individual level of proficiency in one or all of those exercises. The correlation coefficients reflect the shared conditioning nature of these events.

The PFT events do not reflect a great deal of variance in scores. This condition casts some doubt as to the reliability of the test itself, either in concept or in scoring. The situation is exemplified by the fact that a review of the raw pullup scores reflects only an 18 percent variance from the 100th percentile.

The importance of this study lies in the results of correlation between the PFT events and the representative taxonomy (test) events. The most significant of these was the correlation between pullups and obstacle course performance which resulted in a coefficient of .349, a weak correlation. The most significant correlations between PFT events and test events appear in figure 4-3 and are numerically superscripted in order.

This markedly reduced series of correlations may be explained, in part, by the fact that the swim and obstacle course tests require a great deal of task specificity. The highly practiced events of the PFT do not compare well to these task-specific tests because PFT events are designed as measures of general physical conditioning rather than skill or coordination measurements.

The significance of p-values and t-values was not considered for this study. These tests could not be effectively conducted because of the very low degree of variance in the data used. As was mentioned previously, the interpretation for this lack of variance is the test subjects' arbitrary termination of effort upon reaching the maximum score.

The same is not true for run and obstacle course performance scores. Although there is considerable variance among the scores of those tests, the correlation coefficient (.162) indicates a very weak relationship.

In descending order, the most significant correlations were pullups to situps (.617), situps to run (.493), pullups to run (.432), pullups to obstacle course (.349), situps to obstacle course (.206), and pullups to swim (.205). Linear regressions were calculated for these correlations and graphic plots were produced for each. The intent was to learn the nature of the relationships suggested by the coefficients of correlation.

Each regression showed a positive correlation between the events being compared. Each plot also depicted where most of the Marines undergoing the PFT stopped their effort. This fact is attributable to the scoring methods used for the test which require no further effort once maximum performance in an event is reached. This is especially true for pullups and situps. These plots suggest that if no such arbitrary definitions of maximal performance on the PFT existed, the resultant scores would be more widely varied. The results of those regressions appear at Appendix D.

In the final analysis, it appears that there is a coincidental relationship (correlation) between the events of the PFT. The comparison of the PFT events to the test events, in contrast, produced only marginally acceptable coefficients of correlation. In the strictest interpretation, there appears to be only an incidental relationship between the PFT and the types of physical events found in amphibious assaults.

It must be considered that these correlations and regressions result in what can best be termed an "educated guess." In other words, the results of the analysis are not infallible. Although the data used in this study are the scores of an officer basic class, the data used and the tests performed provide an adequate level of reliability for the conclusions drawn from this analysis.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions. This research produced several conclusions. Each of these has some basis in the assessment of physical fitness for Marines participating in amphibious operations. On a larger scale, some conclusions may also affect current perceptions of physical fitness in the Marine Corps.

The research question for this study was "Do the tasks measured by the Marine Corps physical fitness test adequately assess the fitness needs of Marines in an amphibious assault?" The answer to that question, based on the analysis discussed in Chapter Four, is that some degree of assessment is performed by the test; however, the adequacy of that assessment is debatable.

As was noted in this research, very few amphibious assaults have been conducted across beaches devoid of obstacles, either natural or manmade. Further, amphibious assaults will always be conducted in close proximity to, or in contact with water. The data in this study suggests that the PFT only provides a weak to very weak assessment of a

Marine's physical capabilities in an amphibious warfare environment. Therefore, our method of testing is suspect.

Grouping the taxonomy events under the sample tasks may have increased the chance of error in the analysis. As stated previously, however, the quality of the data available for this study and the general characteristics of the comparison permitted fairly accurate correlations. Since a sample population was not available for detailed test administration, extrapolation of evidence was required to draw conclusions.

The correlation showed the events of the PFT to be positively related to each other. Also apparent were the weak correlations between pullups and the obstacle course test, and situps and the obstacle course test.

In the swim test, only the comparison to pullups showed any relationship. At .205, however, this weak coefficient may not be conclusive enough to assume a relationship between the two events.

In the Davis, et al. study of physical fitness requirements for Marines, the authors wrote that "the numbers of Marines observed during the jungle phase of this study that could not swim, or atleast [sic] who swam poorly, was unacceptible [sic] by anyone's standards."[1] That study was concluded in 1986 and Marine Corps Order 1510.29A, Individual Water Survival and Swimming Training, was effective as of 11 May 1981. Given the impressions of previous researchers and the evidence in this study that the PFT does not greatly assist in predicting a Marine's ability to swim, the importance of swimming may be underestimated in the Marine Corps.

During this study, loaded marching could not be compared with PFT performance. After communicating with TBS and SOI, it was learned that although conditioning hikes are part of the training regimens at those schools, assessments of individual performance do not occur. Rather, conditioning marches appear to be used to develop unit cohesion and motivation, and to ensure the physical readiness of the unit as a whole.

In Drews' 1983 study on physical fitness requirements of soldiers in U.S. Army light infantry divisions, the author concluded that "Extended marching with loads was determined to be the most demanding physical requirement for light infantry personnel."[2] Coupled with the fact that loaded marching appeared in the taxonomy of events for this study, it appears that event is an important element in assessing a Marine's physical condition. There exists, however, no institutional assessment of individual performance for this event.

Based on this study, it can be stated that the PFT bears a slight relationship to the taxonomy of physical tasks found in an amphibious assault. It appears, however, that the quality of the correlations determined for the PFT events and test events suggests the absence of a conclusive relationship. The more readily demonstrable relationships, especially when PFT events are compared to themselves, seem attributable to the common conditioning nature of the events.

The weak to very weak correlations found when comparing the PFT events to the test events do not suggest an unconditional relationship. It appears that the conditioning-specific PFT events do not lend themselves well to comparison with task-specific events such as swimming or obstacle negotiation. There is no reason, based on this study, to believe that the PFT adequately tests a Marine's physical ability to participate successfully in an amphibious assault.

Recommendations. The following is a list of recommendations offered as a result of this study.

1. This study should be repeated. Evidence should be gathered that will assist in determining if the current PFT is suited to the task of assessing the physical fitness needs of Marines.

a. To do this, a mission essential task list (METL) should be developed for each of the most probable combat environments Marines could expect to encounter.

b. Marines should be tested on these representative tasks to obtain baseline performance.

c. Resultant baseline performance should be compared to PFT performance to learn the extent to which they are related. If the PFT and the representative events are related, then the test measures what it should. If not, the Marine Corps needs to adopt a new test capable of measuring the physical fitness of our Marines for service in combat.

2. In this study, data were gathered based on availability. As a result, the data reflected the performance levels of a student officer company in training. During a replication of this study, data should be gathered from units that possess a normally distributed population (enlisted to officer). This would provide a more accurate assessment of the general level of fitness in the Marine Corps.

3. Testing the validity of the PFT should be done through data collected specifically for that purpose. In this study, the representative tasks were selected, in part, on the availability of those data. Any attempts to validate the PFT should be conducted using Fleet Marine Force units. Once the quantitative assessments have been completed, analysis may be conducted and conclusions drawn in the laboratory.

4. Consideration should be given to deciding the usefulness of a timed, measured swim test. The current and planned tests, although of increasing frequency, are largely

academic. They are conducted to ensure that Marines possess the basic skills required to survive in the water. Because of the amphibious nature of the Marine Corps, however, its personnel should be required to attain a level of swimming proficiency equal to or greater than the most stringent requirements of any other service.

5. A loaded marching event should be part of the Marine Corps fitness battery. This and previous research stress the importance and utility of such an event. That event should allow the quantitative assessment of each Marine's ability to complete a known distance march, bearing a standard load, within a prescribed time.

6. This analysis suggests that the current PFT does not provide a great deal of variance in individual test scores. Two possible conditions are identifiable: (1) that a new test is needed which will more effectively test an individual's level of physical fitness, or (2) that the method for scoring the current test is not valid and should be revised.

During an amphibious operation, sustained physical exertion is necessary to ensure that the landing force arrives on the beach with a minimum of nonbattle injuries. Such exertions are not ceased at a specific time or because a certain number of event repetitions are performed. There is a need to quantify a Marine's level of physical fitness, and the test used should be empirically valid, challenging, and directly related to combat tasks.

Additional research should be conducted to identify this apparent shortfall in test administration or scoring. As can be seen by the analysis presented in this study, Marines may be attaining an institutional level of physical fitness that is unrelated to current physiological norms.

The success of an amphibious assault depends on how quickly the assaulting force can build up its combat power ashore.[3] By their nature, amphibious operations are planned to the minute. Should a delay occur between the lifting of naval gunfire and the arrival ashore of the first waves of the assault force, the enemy may gain a respite that can be used to reorganize the defense and inflict serious losses on the landing force.[4]

Because of that low tolerance for timing errors, each system involved in an amphibious operation must operate almost flawlessly. Of all the "systems" involved, the Marines themselves represent the most important and volatile elements. They must possess a resistance to what Clausewitz called the "friction" of war.[5] After having been trained to perfection in their individual combat tasks, our Marines must not become casualties because of their inability to swim ashore in heavy surf or because they are unable to negotiate obstacles on the beach.

Beyond their technical training, every member of the assault force should be physically prepared to participate in the operation. Based on the evidence in this study, some of those preparations appear to transcend the fundamental physical fitness assessment provided by the PFT.

As the United States draws down its Armed Forces, more will be expected of the remaining forces in terms of capability and lethality. Straightforward training techniques must be employed and all Marines challenged to expand their physical fitness repertoire. By accomplishing this, the capability of the individual Marine can be improved. When the order comes over the ship's intercom to "land the landing craft," every Marine should be confident of his abilities, and ready to perform at peak condition in each phase of the amphibious assault.

ENDNOTES

[1]P. Davis, C. Dotson, and B. Sharkey, Physical Fitness Requirements of United States Marine Corps MOS 0311 (Langley Park, VA: Institute of Human Performance, February 1986), 51.

[2]F. Drews, Physical Fitness Requirements for Sustained Combat Operations of the Light Infantry, 9th Infantry Division, Ft. Lewis, Washington 19-30 July 1983 (Carlisle Barracks, PA: U.S. Army War College, Army Physical Fitness Research Institute, 10 September 1984), 31.

[3]Linn, T. "Over-the-Horizon Assault: The Future of the Corps," Marine Corps Gazette 71 (December 1987): 44.

[4]Isley, J., P. Crowl. The U.S. Marines and Amphibious War. (Princeton: Princeton University, 1951), 251.

[5]Clausewitz, C. On War. Edited by A. Rapoport. Translated by J. Graham. (Middlesex: Penguin, 1968), 160.

APPENDIX A

RAW DATA*

RAW DATA - MMAS-RAW.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
1	20	80	.3661	100	.0175
2	20	74	.3719	115	.0158
3	20	80	.3322	115	.0158
4	20	80	.3136	115	.0189
5	20	80	.3206	115	.0169
6	20	80	.3417	115	.0150
7	26	97	.2897	115	.0161
8	20	80	.3417	115	.0200
9	20	80	.3303	100	.0161
10	20	80	.3281	115	.0197
11	15	80	.3619	115	.0192
12	20	80	.3222	115	.0169
13	20	80	.3850	115	.0211
14	20	80	.3519	115	.0172
15	20	80	.3619	115	.0200
16	20	80	.3067	115	.0156
17	20	80	.3286	115	.0192
18	20	80	.3139	85	.0194
19	20	80	.3364	115	.0178
20	20	80	.3806	115	.0175
21	20	80	.3006	115	.0178
22	20	80	.3767	115	.0167
23	20	88	.2933	115	.0158
24	20	80	.3583	115	.0167
25	20	80	.3211	115	.0147
26	20	80	.3400	115	.0208
27	20	80	.3042	115	.0236
28	20	80	.3211	115	.0183
29	20	80	.3250	115	.0189
30	20	80	.3036	115	.0158
31	20	78	.3614	115	.0192
32	30	92	.2892	115	.0139
33	20	80	.3447	100	.0169
34	19	80	.3853	115	.0169

*Run and O-Course times converted to hundredths

RAW DATA - MMAS-RAW.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
35	20	80	.3750	100	.0181
36	20	80	.3342	115	.0217
37	20	80	.3222	115	.0192
38	20	80	.3100	115	.0186
39	20	80	.3250	100	.0175
40	20	80	.3431	100	.0228
41	20	80	.3267	100	.0222
42	25	90	.2975	100	.0183
43	20	69	.3403	85	.0172
44	20	80	.3458	100	.0183
45	20	80	.3331	100	.0150
46	20	80	.3383	100	.0161
47	20	80	.3617	115	.0161
48	20	80	.3089	100	.0169
49	20	80	.3347	85	.0178
50	20	81	.2739	100	.0217
51	20	80	.2978	100	.0161
52	20	80	.3453	100	.0183
53	18	73	.3289	100	.0203
54	20	80	.3506	100	.0147
55	20	80	.2978	100	.0181
56	20	80	.3064	115	.0178
57	20	80	.3300	100	.0175
58	20	80	.3411	100	.0186
59	20	80	.3542	100	.0147
60	20	80	.3439	100	.0167
61	20	80	.2986	100	.0192
62	20	80	.3033	115	.0158
63	20	80	.2975	115	.0153
64	20	80	.3328	85	.0161
65	20	80	.3367	100	.0172
66	18	71	.3294	100	.0189
67	19	77	.3553	100	.0236
68	20	80	.3075	100	.0133
69	20	80	.3289	100	.0183
70	19	80	.2978	100	.0231
71	20	80	.3300	100	.0178
72	20	91	.2883	115	.0169
73	20	80	.3556	100	.0192
74	20	80	.3022	115	.0225
75	20	103	.2944	85	.0178
76	15	80	.3597	100	.0222
77	20	80	.3461	115	.0167
78	20	75	.3483	100	.0194
79	20	78	.3211	100	.0197
80	20	80	.3325	100	.0181
81	19	80	.3514	100	.0183

RAW DATA - MMAS-RAW.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
82	20	80	.3111	115	.0153
83	20	80	.3550	115	.0239
84	31	91	.2806	115	.0150
85	20	80	.3342	115	.0189
86	20	80	.3286	100	.0156
87	20	80	.3472	115	.0167
88	20	80	.3233	100	.0208
89	17	79	.3378	100	.0208
90	20	80	.3008	115	.0167
91	20	80	.3267	115	.0261
92	20	80	.3239	115	.0156
93	20	80	.3306	100	.0194
94	20	78	.3597	100	.0183
95	28	99	.2642	115	.0164
96	20	80	.3447	100	.0208
97	20	80	.3367	115	.0167
98	20	80	.2922	115	.0258
99	20	80	.3014	85	.0231
100	20	80	.3372	100	.0167
101	20	80	.3089	100	.0219
102	20	80	.3111	100	.0283
103	20	80	.3344	100	.0194
104	20	80	.3414	115	.0161
105	20	80	.3014	100	.0192
106	20	80	.3319	100	.0144
107	19	61	.3692	115	.0186
108	22	74	.3692	115	.0211
109	20	80	.3542	115	.0222
110	35	98	.2919	115	.0167
111	20	69	.3617	100	.0200
112	20	72	.3064	100	.0147
113	20	80	.3375	100	.0183
114	20	80	.3147	100	.0181
115	19	74	.3403	100	.0183
116	20	80	.3356	115	.0164
117	20	80	.3231	115	.0222
118	20	71	.3392	115	.0183
119	20	80	.2667	85	.0186
120	22	80	.3103	100	.0194
121	20	80	.3314	100	.0200
122	26	83	.3186	100	.0203
123	20	80	.3542	85	.0233
124	14	80	.3372	100	.0228
125	20	80	.3444	100	.0203
126	20	80	.3264	100	.0169
127	20	80	.3258	100	.0183
128	20	80	.3425	115	.0208

RAW DATA - MMAS-RAW.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
129	20	80	.3336	85	.0250
130	20	80	.3539	100	.0194
131	25	81	.3064	100	.0186
132	20	80	.3433	100	.0253
133	20	70	.3308	100	.0181
134	20	80	.2914	100	.0192
135	20	80	.3264	100	.0200
136	20	80	.3236	100	.0192
137	19	80	.3789	100	.0208
138	13	80	.3481	100	.0272
139	20	80	.3122	115	.0208
140	20	80	.3308	100	.0153
141	20	70	.3411	115	.0194
142	22	96	.2981	115	.0197
143	17	70	.3222	100	.0211
144	37	108	.2972	115	.0147
145	30	80	.3036	115	.0147
146	20	80	.3222	85	.0156
147	20	80	.0386	100	.0175

APPENDIX B

NORMALIZED DATA*

NORMALIZED DATA - MMASNORM.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
1	.541	.741	.722	.87	.76
2	.541	.685	.71	1.0	.842
3	.541	.741	.795	1.0	.842
4	.541	.741	.842	1.0	.704
5	.541	.741	.824	1.0	.787
6	.541	.741	.773	1.0	.887
7	.703	.898	.912	1.0	.826
8	.541	.741	.773	1.0	.665
9	.541	.741	.80	.87	.826
10	.541	.741	.805	1.0	.675
11	.405	.741	.73	1.0	.693
12	.541	.741	.82	1.0	.787
13	.541	.741	.686	1.0	.63
14	.541	.741	.751	1.0	.773
15	.541	.741	.73	1.0	.665
16	.541	.741	.861	1.0	.853
17	.541	.741	.804	1.0	.693
18	.541	.741	.842	.739	.686
19	.541	.741	.785	1.0	.747
20	.541	.741	.694	1.0	.76
21	.541	.741	.879	1.0	.747
22	.541	.741	.701	1.0	.796
23	.541	.815	.901	1.0	.842
24	.541	.741	.737	1.0	.796
25	.541	.741	.823	1.0	.905
26	.541	.741	.777	1.0	.639
27	.541	.741	.869	1.0	.564
28	.541	.741	.823	1.0	.727
29	.541	.741	.813	1.0	.704
30	.541	.741	.87	1.0	.842
31	.541	.722	.731	1.0	.643
32	.811	.852	.914	1.0	.993
33	.541	.741	.766	.87	.787
34	.514	.741	.686	1.0	.787

*Run and O-Course times converted to hundredths

NORMALIZED DATA - MMASNORM.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
35	.541	.741	.705	.87	.735
36	.541	.741	.791	1.0	.613
37	.541	.741	.82	1.0	.693
38	.541	.741	.852	1.0	.715
39	.541	.741	.813	.87	.76
40	.541	.741	.77	.87	.583
41	.541	.741	.809	.87	.599
42	.676	.833	.888	.87	.727
43	.541	.639	.776	.739	.773
44	.541	.741	.764	.87	.727
45	.541	.741	.793	.87	.887
46	.541	.741	.781	.87	.826
47	.541	.741	.73	1.0	.826
48	.541	.741	.855	.87	.787
49	.541	.741	.789	.739	.747
50	.541	.741	.965	.87	.613
51	.541	.741	.887	.87	.826
52	.541	.741	.765	.87	.727
53	.486	.704	.803	.87	.655
54	.541	.741	.754	.87	.893
55	.541	.741	.887	.87	.735
56	.541	.741	.862	1.0	.747
57	.541	.741	.801	.87	.76
58	.541	.741	.775	.87	.715
59	.541	.741	.746	.87	.905
60	.541	.741	.768	.87	.796
61	.541	.741	.885	.87	.693
62	.541	.741	.871	1.0	.842
63	.541	.741	.888	1.0	.865
64	.541	.741	.794	.739	.826
65	.541	.741	.785	.87	.773
66	.486	.657	.802	.87	.723
67	.514	.713	.744	.87	.564
68	.541	.741	.859	.87	1.0
69	.541	.741	.803	.87	.727
70	.514	.741	.887	.87	.576
71	.541	.741	.801	.87	.747
72	.541	.843	.916	1.0	.787
73	.541	.741	.743	.87	.693
74	.541	.741	.874	1.0	.591
75	.541	.954	.897	.739	.747
76	.405	.741	.735	.87	.599
77	.541	.741	.763	1.0	.796
78	.541	.694	.759	.87	.686
79	.541	.722	.775	.87	.675
80	.514	.741	.795	.87	.735
81	.541	.741	.752	.87	.727

NORMALIZED DATA - MMASNORM.DBF (MCLEAN) 03-20-1992

RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
82	.541	.741	.849	1.0	.869
83	.541	.741	.744	1.0	.556
84	.838	.843	.942	1.0	.887
85	.541	.741	.791	1.0	.704
86	.541	.741	.804	.87	.853
87	.541	.741	.761	1.0	.796
88	.541	.741	.817	.87	.639
89	.459	.731	.782	.87	.639
90	.541	.741	.878	1.0	.796
91	.541	.741	.809	1.0	.51
92	.541	.741	.816	1.0	.853
93	.541	.741	.799	.87	.686
94	.541	.722	.735	.87	.727
95	.757	.917	1.0	1.0	.811
96	.541	.741	.766	.87	.639
97	.541	.741	.785	1.0	.796
98	.541	.741	.904	1.0	.516
99	.541	.741	.877	.739	.576
100	.541	.741	.784	.87	.796
101	.541	.741	.855	.87	.607
102	.541	.741	.849	.87	.47
103	.541	.741	.79	.87	.686
104	.541	.741	.774	1.0	.826
105	.541	.741	.877	.87	.693
106	.541	.741	.796	.87	.924
107	.514	.568	.716	1.0	.715
108	.595	.685	.716	1.0	.63
109	.541	.741	.746	1.0	.599
110	.946	.907	.905	1.0	.796
111	.541	.639	.73	.87	.665
112	.541	.667	.862	.87	.905
113	.541	.741	.783	.87	.727
114	.541	.741	.84	.87	.735
115	.514	.685	.776	.87	.727
116	.541	.741	.787	1.0	.811
117	.541	.741	.818	1.0	.599
118	.541	.657	.779	1.0	.727
119	.541	.741	.72	.739	.715
120	.595	.741	.851	.87	.686
121	.541	.741	.797	.87	.665
122	.703	.769	.829	.87	.655
123	.541	.741	.746	.739	.571
124	.378	.741	.784	.87	.583
125	.541	.741	.767	.87	.655
126	.541	.741	.809	.87	.787
127	.541	.741	.811	.87	.727
128	.541	.741	.771	1.0	.639

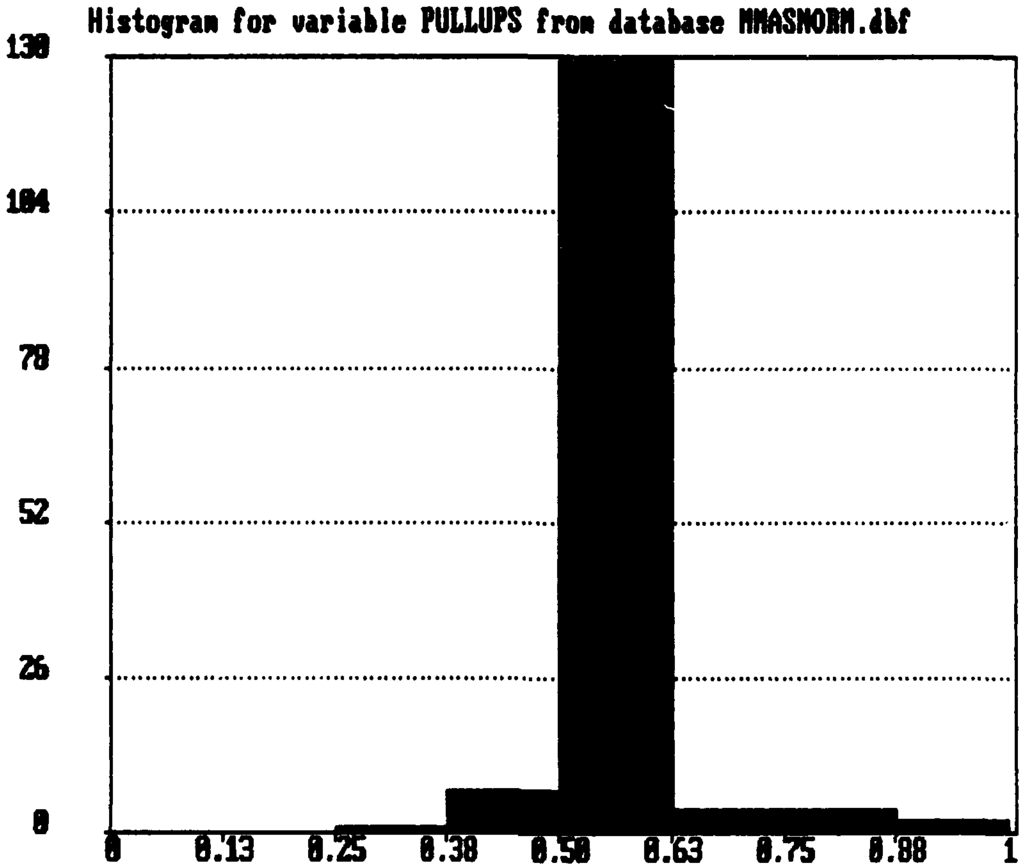
NORMALIZED DATA - MMASNORM.DBF (MCLEAN) 03-20-1992

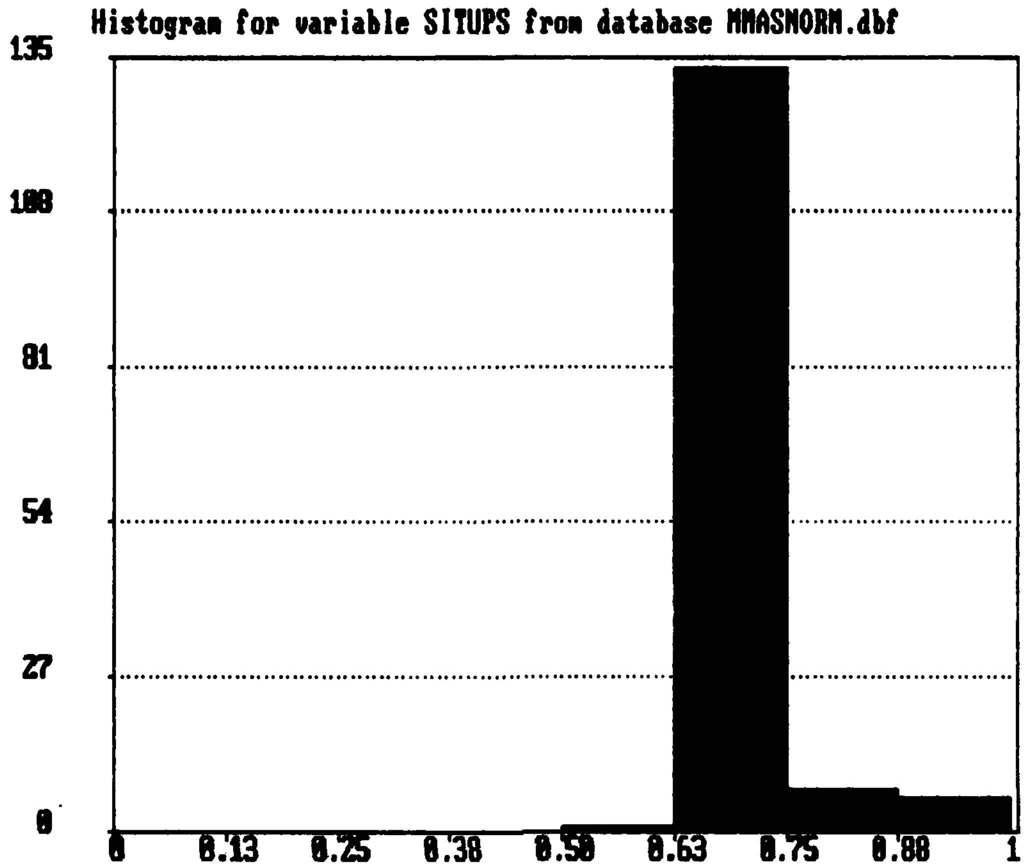
RECORD	PULLUPS	SITUPS	RUN	SWIM	O-COURSE
129	.541	.741	.792	.739	.532
130	.541	.741	.747	.87	.686
131	.676	.75	.862	.87	.715
132	.541	.741	.77	.87	.526
133	.541	.649	.799	.87	.735
134	.541	.741	.907	.87	.693
135	.541	.741	.809	.87	.665
136	.541	.741	.816	.87	.693
137	.514	.741	.697	.87	.639
138	.351	.741	.759	.87	.489
139	.541	.741	.846	1.0	.639
140	.541	.741	.799	.87	.869
141	.541	.648	.775	1.0	.676
142	.595	.889	.886	1.0	.675
143	.459	.648	.82	.87	.63
144	1.0	1.0	.889	1.0	.905
145	.811	.741	.87	1.0	.905
146	.541	.741	.82	.739	.853
147	.541	.741	.87	.87	.76

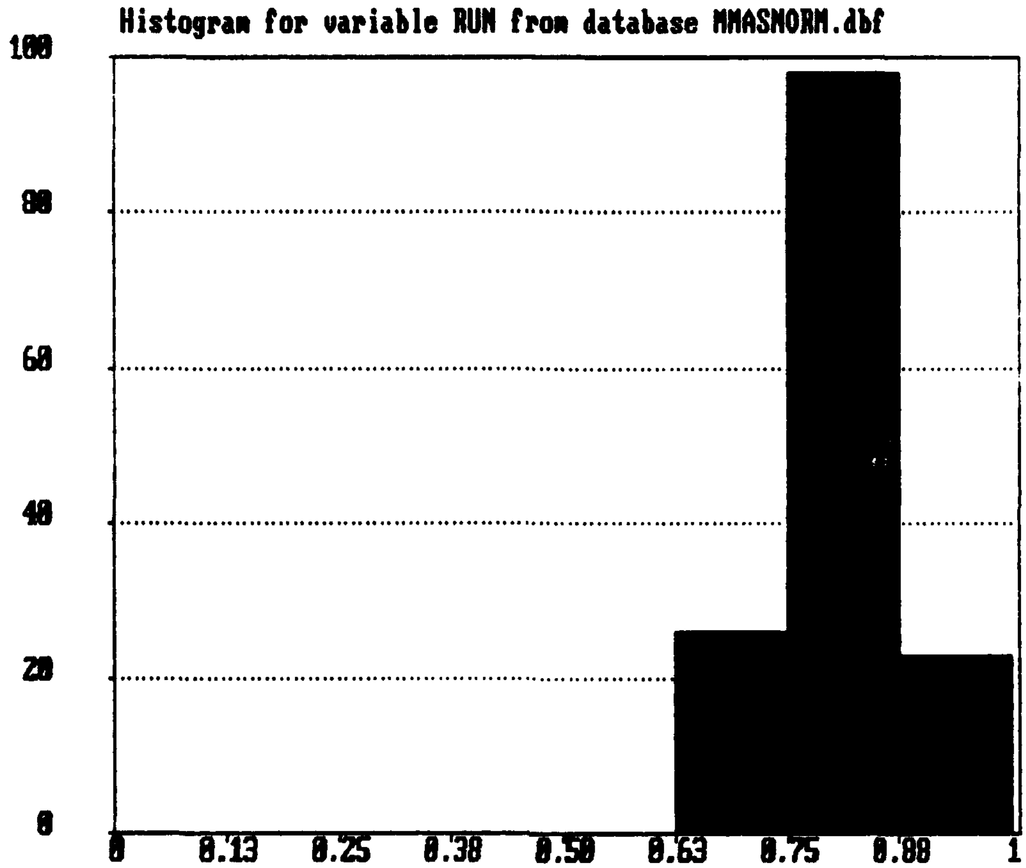
APPENDIX C

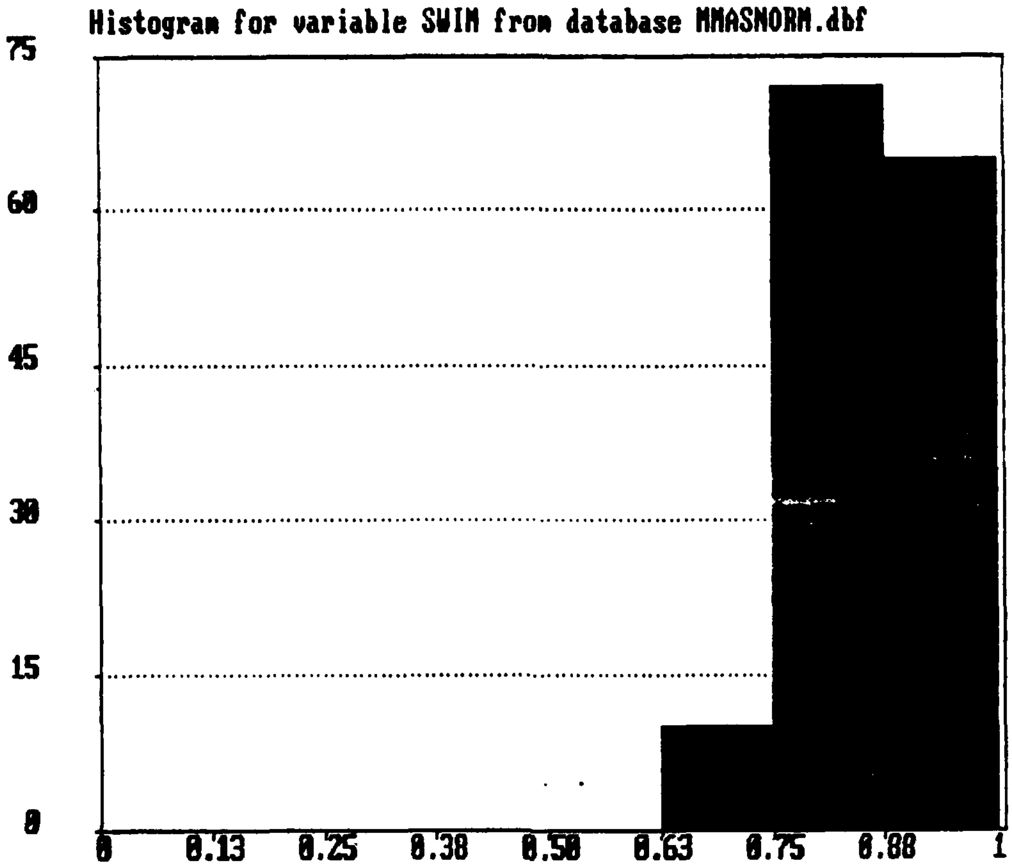
HISTOGRAMS

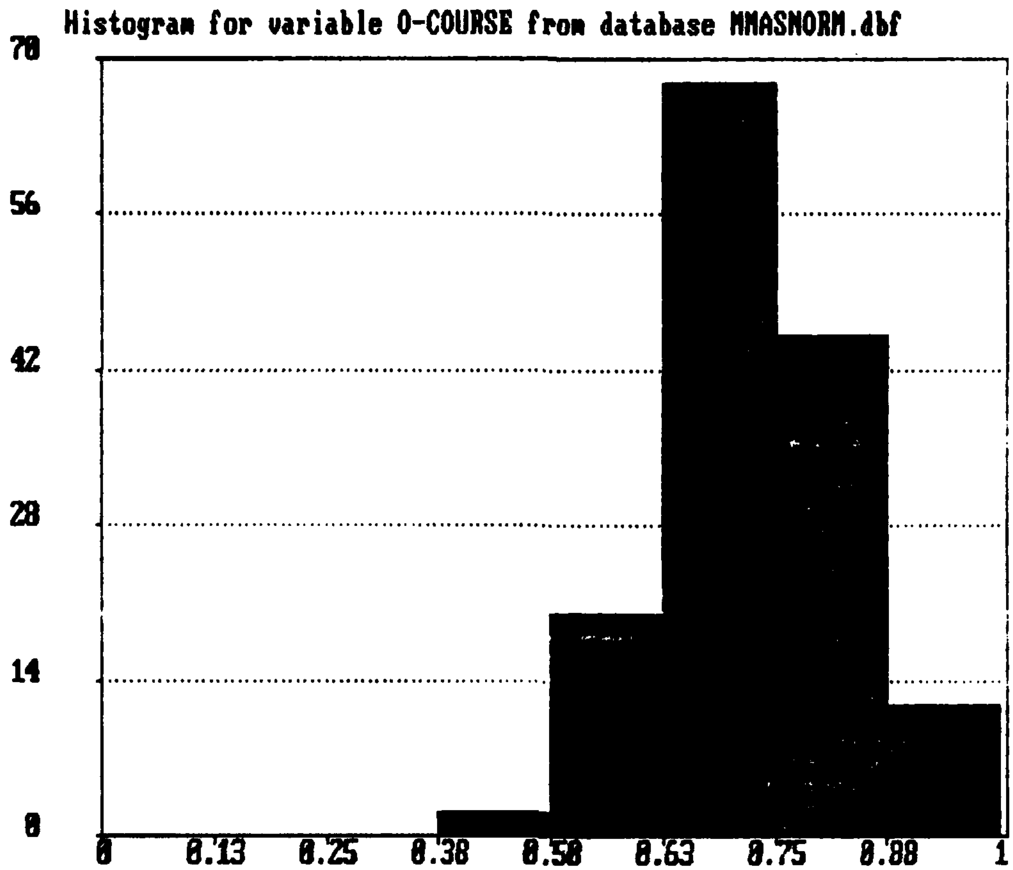
Histograms of the normalized data used in this study appear in the following 5 pages (94-98).


Histogram for variable PULLUPS from database MMASNORM.dbf
130
104
78
52
26
0
0
0.13
0.25
0.38
0.50
0.63
0.75
0.88
1


Histogram for variable SITUPS from database MMASNORM.dbf
135
108
81
54
27
0
0
0.13
0.25
0.38
0.50
0.63
0.75
0.88
1


Histogram for variable RUN from database MMASNORM.dbf
100
80
60
40
20
0
0
0.13
0.25
0.38
0.50
0.63
0.75
0.88
1


Histogram for variable SWIM from database MMASNORM.dbf
75
60
45
30
15
0
0
0.13
0.25
0.38
0.50
0.63
0.75
0.88
1



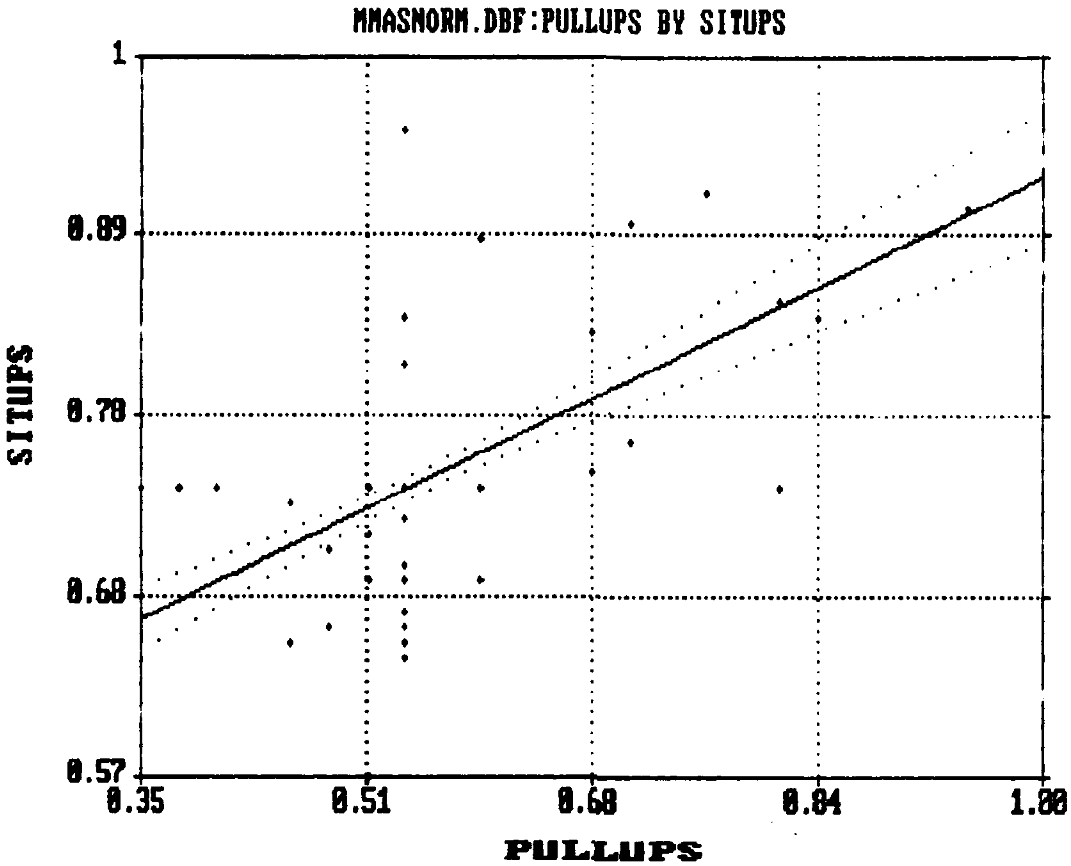
Histogram for variable O-COURSE from database MMASNORM.dbf
70
56
42
28
14
0
0
0.13
0.25
0.38
0.50
0.63
0.75
0.88
1

APPENDIX D

LINEAR REGRESSIONS

The results of the linear regressions conducted on positively correlated data appear in the following 12 pages (100-111). Bands around plots reflect a 95 percent level of confidence.

```
Simple Linear Regression Procedure

Independent Variable (X):  PULLUPS
Dependent Variable   (Y):  SITUPS

147 data points used in the calculation.

MEAN X = 0.552          S.D. X   = 0.077          CORR XSS = 0.06
MEAN Y = 0.744          S.D. Y   = 0.054          CORR YXX = 0.38
REGR MS= 0.143          RESID MS= 0.002

Pearson's r (Correlation Coefficient)= 0.6172
R-Square= 0.3809

The linear regression equation is:
SITUPS =  .518679  +  .4077595 * PULLUPS

Test of hypothesis to determine significance of
relationship:
H (null):  Slope = 0  or H (null):  r = 0  (two-tailed test)
t = 9.45 with 145 degrees of freedom p = 0.000

A low p-value implies that the slope does not = 0.
```


MMASNORM.DBF:PULLUPS BY SITUPS
1
0.89
0.78
0.68
0.57
SITUPS
0.35
0.51
0.68
0.84
1.00
PULLUPS

Simple Linear Regression Procedure

Independent Variable (X): PULLUPS
Dependent Variable (Y): RUN

147 data points used in the calculation.

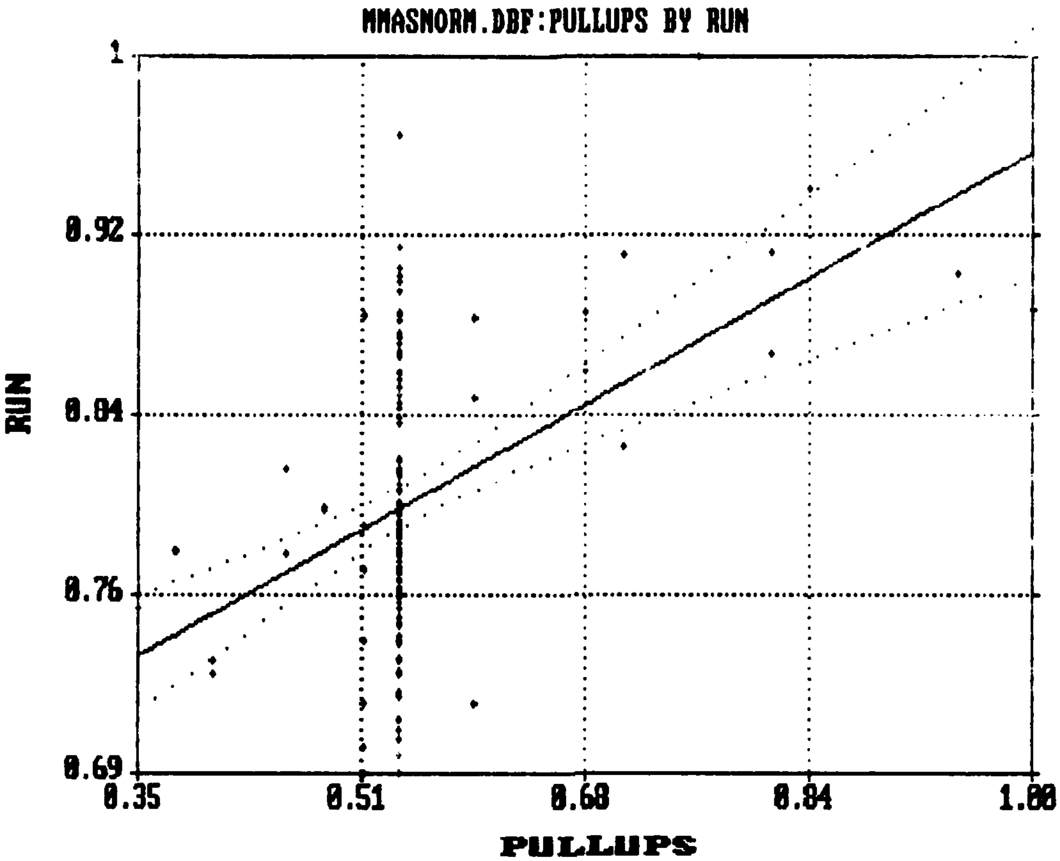
MEAN X = 0.552	S.D. X = 0.077	CORR XSS = 0.86
MEAN Y = 0.806	S.D. Y = 0.060	CORR YXX = 0.53
REGR MS= 0.099	RESID MS= 0.003	

Pearson's r (Correlation Coefficient)= 0.4321
R-Square= 0.1867

The linear regression equation is:
RUN = .6192262 + .3385411 * PULLUPS

Test of hypothesis to determine significance of relationship:
H (null): Slope = 0 or H (null): r = 0 (two-tailed test)
t = 5.77 with 145 degrees of freedom p = 0.000

A low p-value implies that the slope does not = 0.


MMASNORM.DBF:PULLUPS BY RUN
1
0.92
0.84
0.76
0.69
RUN
0.35
0.51
0.68
0.84
1.00
PULLUPS

Simple Linear Regression Procedure

Independent Variable (X): SITUPS
Dependent Variable (Y): RUN

147 data points used in the calculation.

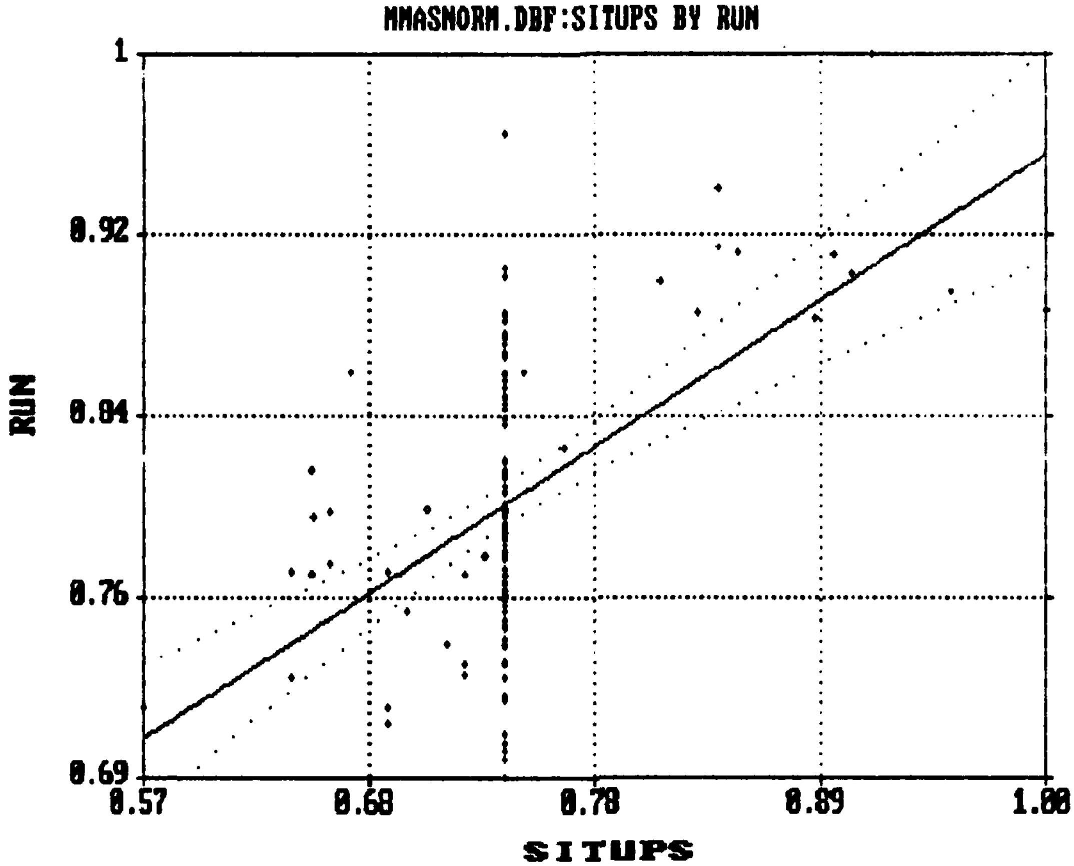
MEAN X = 0.744	S.D. X = 0.051	CORR XSS = 0.38
MEAN Y = 0.806	S.D. Y = 0.060	CORR YXX = 0.53
REGR MS= 0.128	RESID MS= 0.003	

Pearson's r (Correlation Coefficient)= 0.4931
R-Square= 0.2432

The linear regression equation is:
RUN = .3711561 + .5847608 * SITUPS

Test of hypothesis to determine significance of relationship:
H (null): Slope = 0 or H (null): r = 0 (two-tailed test)
t = 6.83 with 145 degrees of freedom p = 0.000

A low p-value implies that the slope does not = 0.


MMASNORM.DBF:SITUPS BY RUN
RUN
1
0.92
0.84
0.76
0.69
0.57
0.68
0.78
0.89
1.00
SITUPS

Simple Linear Regression Procedure

Independent Variable (X): PULLUPS
Dependent Variable (Y): SWIM

147 data points used in the calculation.

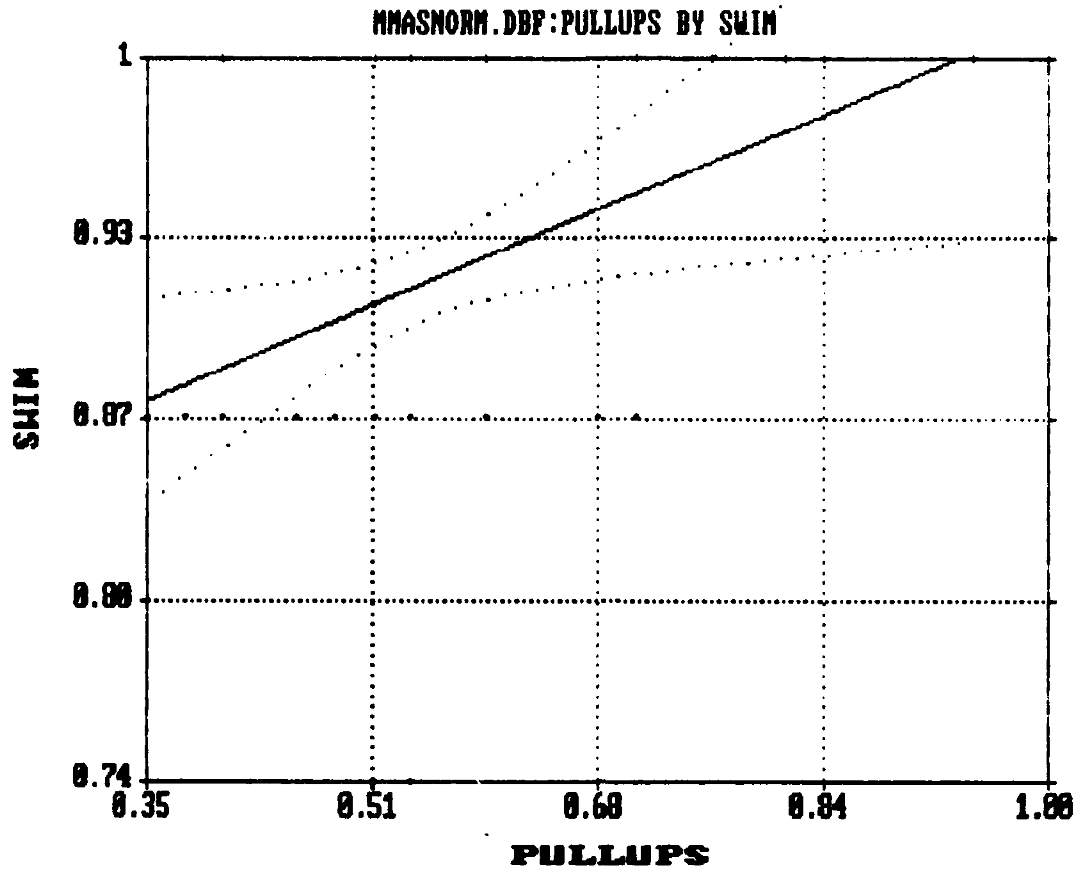
MEAN X = 0.552	S.D. X = 0.077	CORR XSS = 0.86
MEAN Y = 0.919	S.D. Y = 0.080	CORR YXX = 0.92
REGR MS= 0.039	RESID MS= 0.006	

Pearson's r (Correlation Coefficient)= 0.2049
R-Square= 0.0420

The linear regression equation is:
SWIM = .8014296 + .2122973 * PULLUPS

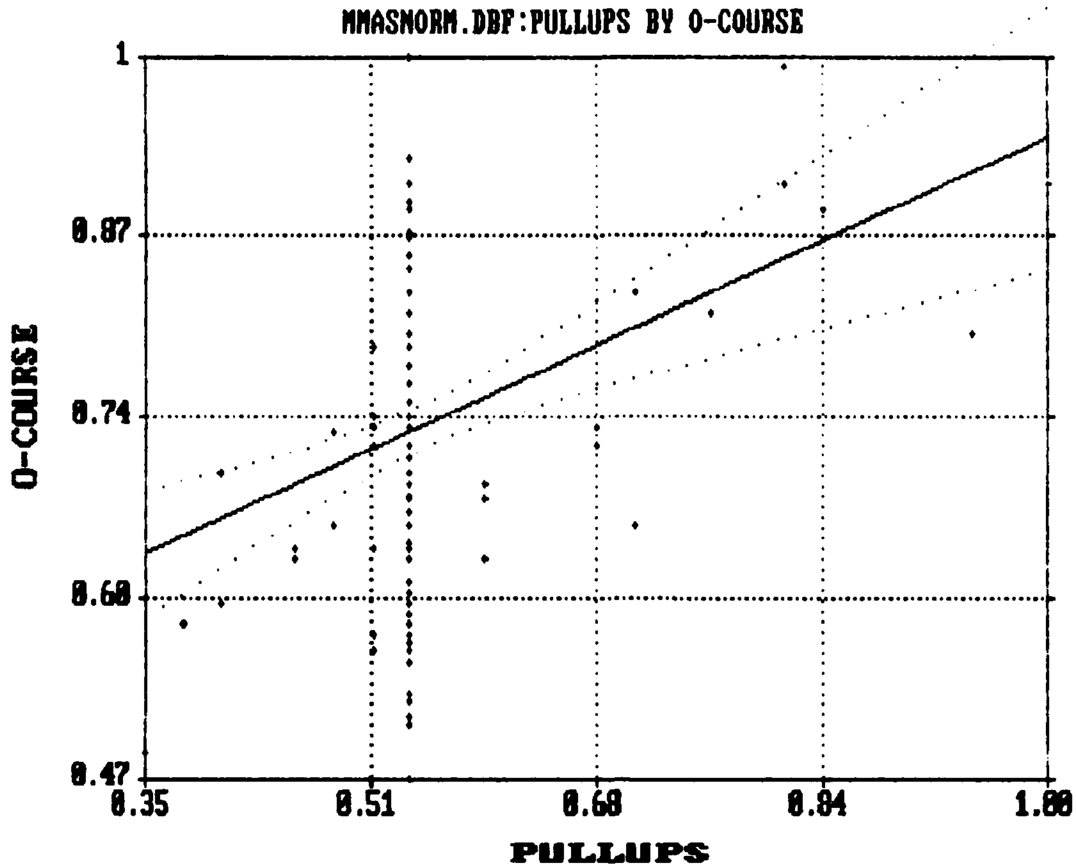
Test of hypothesis to determine significance of relationship:
H (null): Slope = 0 or H (null): r = 0 (two-tailed test)
t = 2.52 with 145 degrees of freedom p = 0.013

A low p-value implies that the slope does not = 0.



MMASNORM.DBF:PULLUPS BY SWIM
1
0.93
0.87
0.80
0.74
0.35
0.51
0.68
0.84
1.00
SWIM
PULLUPS

```
Simple Linear Regression Procedure

Independent Variable (X):  PULLUPS
Dependent Variable   (Y):  O-COURSE

147 data points used in the calculation.

MEAN X = 0.552          S.D. X   = 0.077          CORR XSS = 0.86
MEAN Y = 0.728          S.D. Y   = 0.104          CORR YXX = 1.57
REGR MS= 0.191          RESID MS= 0.010

Pearson's r (Correlation Coefficient)= 0.3486
R-Square= 0.1215

The linear regression equation is:
O-COURSE=  .4686829 +  .4706777 * PULLUPS

Test of hypothesis to determine significance of
relationship:
H (null):  Slope = 0  or H (null):  r = 0  (two-tailed test)
t = 4.48 with 145 degrees of freedom p = 0.000

A low p-value implies that the slope does not = 0.
```


MMASNORM.DBF:PULLUPS BY O-COURSE
O-COURSE
PULLUPS
1
0.87
0.74
0.60
0.47
0.35
0.51
0.68
0.84
1.00

Simple Linear Regression Procedure

Independent Variable (X): SITUPS
Dependent Variable (Y): O-COURSE

147 data points used in the calculation.

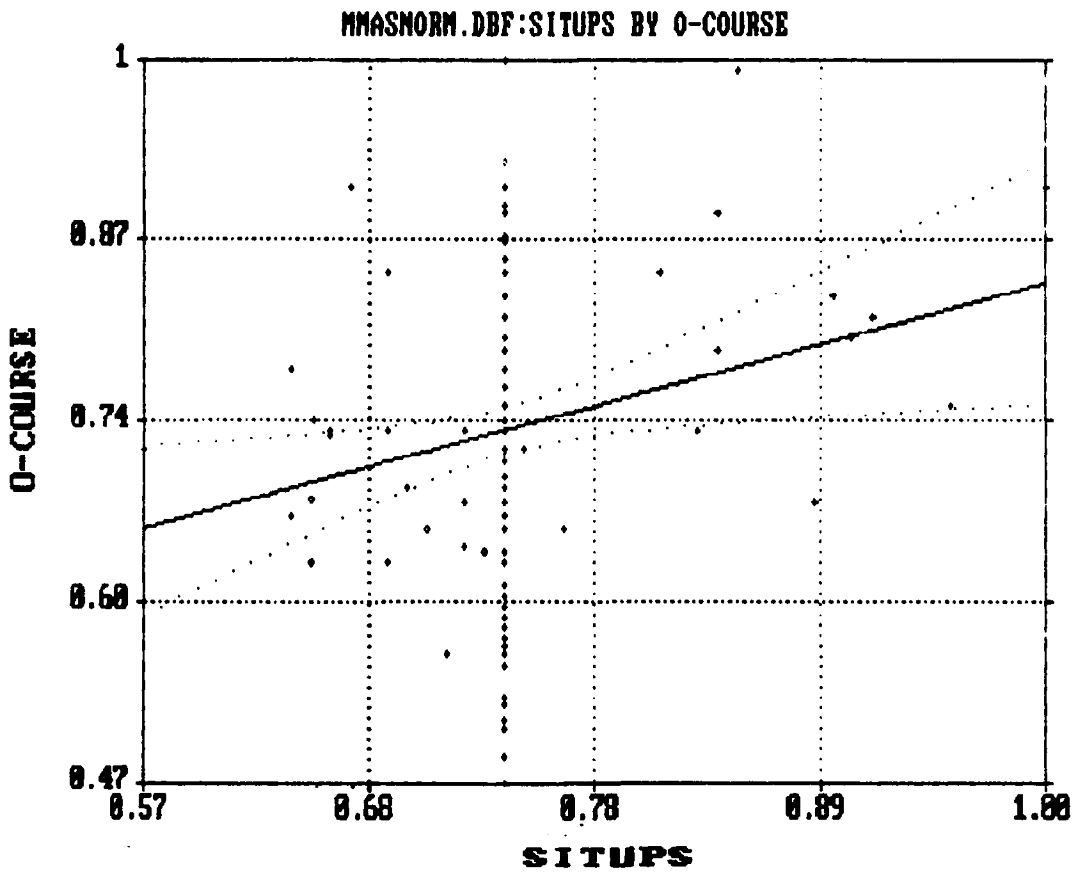
MEAN X = 0.744	S.D. X = 0.051	CORR XSS = 0.38
MEAN Y = 0.728	S.D. Y = 0.104	CORR YXX = 1.57
REGR MS= 0.066	RESID MS= 0.010	

Pearson's r (Correlation Coefficient)= 0.2056
R-Square= 0.0423

The linear regression equation is:
O-COURSE = .4159141 + .4201849 * SITUPS

Test of hypothesis to determine significance of relationship:
H (null): Slope = 0 or H (null): r = 0 (two-tailed test)
t = 2.53 with 145 degrees of freedom p = 0.012

A low p-value implies that the slope does not = 0.


MMASNORM.DBF:SITUPS BY O-COURSE
O-COURSE
1
0.87
0.74
0.60
0.47
0.57
0.68
0.78
0.89
1.00
SITUPS

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