

AN ABSTRACT OF THE THESIS OF

Jeremy R. Hawkins for the degree of Master of Science in Exercise and Sport Science,
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Title: Assessment of Pre-Fire Season Physical Fitness Training Among Bureau of Land
Management Wildland Firefighters.

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Abstract approved:

✓

Rod A. Harter

Wildland firefighters encounter many situations during forest fires that require them to rely on their knowledge, experience, and fitness level for survival. While energy expenditure of wildland firefighters on the fire line has been well established, relatively little is known about the physical fitness level of wildland firefighters when they report to work. The purpose of this descriptive study was to assess the level of pre-fire season physical fitness training in two categories of Bureau of Land Management (BLM) wildland firefighters. A questionnaire was developed using the Delphi method with input from career wildland firefighters and exercise physiologists familiar with the physical demands of wildland firefighting. The questionnaire solicited wildland firefighter demographic information, type and amount of pre-fire season exercise involvement, level of motivation to exercise, estimated current fitness level, and estimated/actual work capacity ("pack") test time. Test-retest reliability of the questionnaire was established using a separate group of Utah BLM wildland firefighters. Administration of the questionnaire took place during the 2003 fire season when the prospective wildland firefighters completed their work capacity ("pack") tests. Test-retest reliability was

estimated using percentage of agreement calculations, while the nonparametric questionnaire data were analyzed using Chi-squared contingency coefficients and Cramer's V statistics. Repeated administration of the questionnaire to the separate group of 26 wildland firefighters over a 1-week interval indicated percent of agreement scores ranging from 38.5% to 100.0%. A total of 163 BLM wildland firefighters from Idaho and Utah (106 engine crew members, 57 hand crew members; mean age, 27.3 ± 7.9 yrs) completed the questionnaire. Significant differences between the engine crew and hand crew groups were found for frequency (35.1% of hand crew members performed > 5 sessions per week v. 30.2% of engine crew members performed 1-2 sessions per week) and for duration (29.8% of hand crew members exercised > 60 minutes per session v. 21.7% of engine crew members exercised < 30 minutes per session) of cardiovascular training ($p < 0.05$). While statistically significant, the differences observed between groups were not meaningful due to low Cramer's V coefficients of 0.27 and 0.25, respectively. For most categories of BLM wildland firefighters, the sole fitness criterion for employment is completion of a 4.83 km field-based hike in ≤ 45 minutes while wearing a 20.4 kg backpack, i.e., the work capacity ("pack") test. While all 163 respondents passed his/her pack test, our results suggest that a wide range of physical fitness levels existed among the wildland firefighters surveyed. Further research is needed to determine if differences exist in pre-fire season training regimens and physical fitness levels between federal government and private contract fire crews. Future studies should investigate how wildland firefighter fitness levels affect job performance, safety and injury incidence and severity rates.

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**Assessment of Pre-Fire Season Physical Fitness Training Among
Bureau of Land Management Wildland Firefighters**

by
Jeremy R. Hawkins

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Jeremy R. Hawkins, Author

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CONTRIBUTION OF AUTHORS

Dr. Rod Harter contributed to the conception and design of the study and questionnaire as well as the drafting, critical revision and final approval of the thesis manuscript.

Dr. Terry Wood contributed to conception and design of the questionnaire as well as the statistical methods employed during the analysis of the data.

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Assessment of Pre-Fire Season Physical Fitness Training Among Bureau of Land Management Wildland Firefighters

Wildland firefighters encounter many situations during forest fires that require them to rely on their knowledge, experience, and fitness level for survival. While energy expenditure of wildland firefighters on the fire line has been well established, relatively little is known about the physical fitness level of wildland firefighters when they report to work. The purpose of this descriptive study was to assess the level of pre-fire season physical fitness training in two categories of Bureau of Land Management (BLM) wildland firefighters. A questionnaire was developed using the Delphi method with input from career wildland firefighters and exercise physiologists familiar with the physical demands of wildland firefighting. The questionnaire solicited wildland firefighter demographic information, type and amount of pre-fire season exercise involvement, level of motivation to exercise, estimated current fitness level, and estimated/actual work capacity ("pack") test time. Test-retest reliability of the questionnaire was established using a separate group of Utah BLM wildland firefighters. Administration of the questionnaire took place during the 2003 fire season when the prospective wildland firefighters completed their work capacity ("pack") tests. Test-retest reliability was estimated using percentage of agreement calculations, while the nonparametric questionnaire data were analyzed using Chi-squared contingency coefficients and Cramer's V statistics. Repeated administration of the questionnaire to the separate group of 26 wildland firefighters over a 1-week interval indicated percent of agreement scores ranging from 38.5% to 100.0%. A total of 163 BLM wildland firefighters from Idaho and Utah (106 engine crew members, 57 hand crew members; mean age, 27.3 ± 7.9 yrs) completed the questionnaire. Significant differences between the engine crew and hand crew groups were found for frequency (35.1% of hand

crew members performed > 5 sessions per week v. 30.2% of engine crew members performed 1-2 sessions per week) and for duration (29.8% of hand crew members exercised > 60 minutes per session v. 21.7% of engine crew members exercised < 30 minutes per session) of cardiovascular training ($p < 0.05$). While statistically significant, the differences observed between groups were not meaningful due to low Cramer's V coefficients of 0.27 and 0.25, respectively. For most categories of BLM wildland firefighters, the sole fitness criterion for employment is completion of a 4.83 km field-based hike in ≤ 45 minutes while wearing a 20.4 kg backpack, i.e., the work capacity ("pack") test. While all 163 respondents passed his/her pack test, our results suggest that a wide range of physical fitness levels existed among the wildland firefighters surveyed. Further research is needed to determine if differences exist in pre-fire season training regimens and physical fitness levels between federal government and private contract fire crews. Future studies should investigate how wildland firefighter fitness levels affect job performance, safety and injury incidence and severity rates.

INTRODUCTION

Wildland firefighters are employed seasonally throughout the western United States by "land management agencies (United States Forest Service, Bureau of Land Management, and State Forestry)."¹ In recent years, numerous private contractors have also begun to employ wildland firefighters, capitalizing on the limited governmental resources and the lucrative business of wildfire suppression. From 1999 to 2003 in the United States alone, 446,703 wildfires were started, consuming more than 28.4 million acres of private, state, and federal land. The cost to suppress these wildfires to federal agencies was nearly 5.5 billion dollars. During this same time period, 116 wildland firefighter fatalities occurred.² Similar statistics are available from countries around the world, including Australia, Greece, Mongolia, Russia, and South Africa.³

One essential physical requirement for wildland firefighter employment is work capacity. Work capacity is operationally defined as "the employee's ability to accomplish production goals without undue fatigue and without becoming a hazard to oneself or coworkers."⁴ Since 1975, wildland firefighter work capacity was tested using the 5-minute Step Test.⁴ The step test is based on the premise that for all submaximal work (stepping up on a 50.8 cm box at a pace of 30 steps/minute³⁵) an individual with a higher level of cardiovascular fitness will have a smaller increase in heart rate and will have a heart rate that returns to normal faster after the submaximal work than an individual with lower cardiovascular fitness.

In response to a need to review fitness testing⁶ and training materials, the United States Forest Service Missoula Technology and Development Center conducted a job task analysis in 1994. The job task analysis resulted in a new form of work capacity testing,

which allowed for three levels of testing, a feature that the Step Test did not include.^{4,7} The specifics of each level of the work capacity test are outlined in Table 1. Every fire line wildland firefighter must demonstrate work capacity by passing the pack test, which “approximates a step test score of 45 ml/kg·min, the established standard for wildland firefighters.”⁸ Each level of the work capacity test has been found to be “job related, safe, inexpensive, brief, easy to administer, valid, reliable, and objective.”⁴ The pack test is currently used by all United States governmental agencies and by other countries throughout the world to test fire line wildland firefighter work capacity.⁹

Table 1. Specifications for work capacity tests.

Test name	Level of testing	Specifications
Pack test	Arduous	Carry a 20.4 kg pack 4.83 km, in ≤ 45 minutes
Field test	Moderate	Carry a 11.3 kg pack 3.22 km, in ≤ 30 minutes
Walk test	Light	Walk 1.61 km in ≤ 16 minutes

Research has shown that workers possessing aerobic and muscular fitness are able to work longer hours in unfavorable conditions.^{4,8} Fit workers are injured less frequently, and recover more quickly from injury than less fit individuals.^{4,8} No research has been conducted to assess how physically fit wildland firefighters are when they report to work. Wildland firefighters may be required to work at a high, prolonged level immediately after reporting for seasonal employment. Separate studies conducted by Ruby et al.¹ and Sharkey⁴ revealed energy expenditure rates of 4000 kcal to greater than 6000 kcal for a 14-hour work day are not uncommon. The level of fitness obtained prior to reporting to work will influence how well the wildland firefighter will meet these demands. A lack of fitness can be detrimental to not only the individual wildland firefighter, but to his or her crew as well.⁴ However, due to the seasonal nature of wildland firefighting, many wildland firefighters arrive at work with the same physical fitness challenges that face the general public.

The purpose of this descriptive study was to assess pre-fire season physical fitness training among Bureau of Land Management (BLM) wildland firefighters. Additionally, we conducted this study in an attempt to determine what differences exist between wildland firefighter classifications in respect to type and amount of pre-fire season exercise involvement, level of motivation to exercise, and estimated current fitness level.

METHODS AND PROCEDURES

Wildland firefighters employed by the BLM during the 2003 fire season (mid-April through mid-October) served as the population of interest. BLM wildland firefighters were selected due to the available number of participants and the ability to access wildland firefighters in the different classifications listed in Table 2.

Table 2. Definition of wildland firefighter job classifications.

Classification	Job Description
Smokejumper	Arrive on fires via airplane and parachute
Hotshot crew	Type I hand crew comprised of 20 highly trained and experienced individuals
Hand crew	Type II hand crew comprised of 20 individuals with less training and experience than a hotshot crew
Helitack	Arrive on fireline via a helicopter, either by landing nearby or rappelling
Engine crew	Work with specialized equipment that can be driven to a fire
Management	Oversee day to day fire operations
Other	Individuals employed in some other capacity (e.g. water tender or bull dozer operator), who take the pack test to qualify for fire assignments should conditions warrant

To qualify for participation in this study, individuals needed to be BLM employees, ranging in age from 18 to 65, who completed the pack test. Eight of the 19 districts and field offices from the Great Basin Region (Southern Idaho, Nevada, and Utah) were selected for recruitment. The costs associated with qualitative research limited the total number of groups recruited. Within the eight selected groups were both the districts in Southern Idaho, three of the six field offices in Nevada, and three of the 11 field offices in Utah. The districts and field offices were selected due to knowledge of their crew makeup, employing wildland firefighters who work on hand crews, helitack, and engines crews. The smokejumper base and the two hotshot crews (1 in Idaho, 1 in Nevada) located within the region were also recruited. An additional 26 wildland firefighters were recruited from the Vernal Utah Field Office to test the reliability of the test instrument. The Vernal Field Office wildland

firefighters were selected because of ease of test-retest administration while the researcher (JH) was employed at the same location. Permission for distribution throughout the Great Basin region was obtained from the state fire management officer for the State of Utah. The participant population sought in this study was not restricted to any gender or ethnic group. Approval to use human subjects was obtained through the Oregon State University Institutional Review Board. Additionally, each wildland firefighter was given a letter outlining informed consent.

Questionnaire

The questionnaire used in this study was developed following the Delphi method.¹¹ Career wildland firefighters and exercise physiologists familiar with the physical demands of wildland firefighting were contacted to determine a consensus on important issues of pre-fire season physical fitness training. Through subsequent rounds of the Delphi method, the questionnaire was designed and refined, until an appropriate tool for the assessment of wildland firefighter fitness patterns was developed (Appendix E). The questionnaire solicited wildland firefighter demographic information, type and amount of pre-fire season exercise involvement, level of motivation to exercise, estimated current fitness level, and estimated/actual pack test time. Following the Delphi method ensured the questionnaire was both content valid and content relevant.

Content reliability of the questionnaire was established using test-retest principles.¹¹ The questionnaire was administered twice over a 1-week interval in June 2003 to wildland firefighters (N=26) from the Vernal Utah Field Office. The data collected from the recruited wildland firefighters were used for reliability purposes only, and were not included in the summary statistics of the larger study.

A packet of questionnaires with a letter of recruitment outlining the purpose, intended use, and instructions for the administration of the questionnaire was sent to each group identified. The questionnaires were administered at the time the wildland firefighter took the pack test or as soon as possible thereafter. All questionnaires were returned via a self-addressed stamped envelope included in the original packet. Approximately three weeks¹² after mailing the questionnaires to the various groups, a letter of reminder was sent to each fire management officer, smokejumper base manager, or hotshot crew superintendent who had not returned their packets. The estimated time commitment for all individuals taking part in this research project was less than five minutes.

Statistical analysis of the data was performed with the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois), version 11.5. The reliability of the questionnaire was estimated using percentage of agreement calculations between the two administrations. The research question was analyzed for statistical and practical significance using non-parametric Chi-squared contingency coefficients and Cramer's V statistics. The alpha level was set at 0.05 with an anticipated medium effect size.

RESULTS

Analysis of the questionnaires administered to establish test-retest reliability revealed percentages of agreement ranging from 38.5% to 100%. Question specific percentages of agreement are found in Table 3. Due to the low percentage of agreement scores for total minutes of exercise for both resistance (46.2%) and cardiovascular (38.5%) exercise, these percentages were not included in any further analyses.

Table 3. Percentage of agreement for the two questionnaire administrations.

Question	Percentage agreement
Motivation for exercise	84.6%
Resistance exercises performed (y/n)	92.3%
Months before fire season?	61.5%
Sessions per week?	76.9%
Minutes per session?	76.9%
Total minutes per week?	46.2%
Specific activity performed?	69.2%
Cardiovascular exercises performed (y/n)	100.0%
Months before fire season?	73.1%
Sessions per week?	80.8%
Minutes per session?	80.8%
Total minutes per week?	38.5%
Specific activity performed?	92.3%
Flexibility/stretching performed (y/n)	84.6%
When performed?	80.8%
Times per week?	69.2%
Specific activity performed?	92.3%
Estimated/actual pack test time	100.0%
Current fitness level	100.0%

The managers of two districts, six field offices, two hotshot crews, and one smokejumper base were recruited for participation. Seven managers recruited their wildland firefighters to take part in the study (Table 4), demonstrating a participation rate of 64%. The seven responding groups consisted of 317 wildland firefighters (Table 4). Of the 317

wildland firefighters recruited, 176 questionnaires were returned, yielding a response rate of 56%.

Table 4. Geographic distribution of questionnaires.

Districts, field offices, and crews	Number of firefighters recruited
Upper Snake River District (Idaho)	80
Lower Snake River District (Idaho)	95
Salt Lake Field Office (Utah)	50*
Moab Field Office (Utah)	30
Cedar City Field Office (Utah)	23
Snake River Hotshots (Idaho)	18
Great Basin Smokejumpers (Idaho)	21
Total	317*

* Estimated number of wildland firefighters recruited due to no response from the Salt Lake Field Office concerning actual number employed.

Due to the similarity of job responsibilities between the wildland firefighter classifications identified, the seven classifications (Table 2) were reduced to two. Individuals classified as smokejumpers, hotshots crew members, hand crew members, and helitack were combined under the classification of hand crew. Those classified as engine crew remained as such, while the individuals who responded as "management" or "other" (N = 13) were eliminated from the study due to an inappropriate fit into one of the above two categories and insufficient data to be considered as their own group. Summary data for the 163 hand crew and engine crew participants appears in Table 5.

Table 5. Summary statistics for two wildland firefighter classifications (mean \pm SD).

Classification	Age (yrs)	Height (m)	Weight (kg)	Experience (yrs)	BMI (kg/m ²)
Hand crew (N = 57)	29.3 \pm 7.1	1.82 \pm 0.08	79.3 \pm 11.1	7.7 \pm 7.6	24.1 \pm 2.9
Engine crew (N = 106)	26.7 \pm 8.2	1.80 \pm 0.08	82.2 \pm 14.2	4.5 \pm 5.2	25.3 \pm 3.5
Overall (N = 163)	27.3 \pm 7.9	1.81 \pm 0.08	81.3 \pm 13.3	5.5 \pm 6.2	24.9 \pm 3.3

The 163 wildland firefighters who completed the questionnaire indicated varying responses to the questions asked. The majority of wildland firefighters indicated maintaining general fitness throughout the year as their motivation to exercise (Table 6). The differences witnessed between the groups were non-significant ($p < 0.05$).

Table 6. Responses to motivation to exercise question.

Response	Hand crew	Engine crew
No specific activity	5.3%	6.6%
Previous experience	19.3%	25.5%
Recommendation – wildland firefighter	1.8%	2.8%
Recommendation – present employer	8.8%	4.7%
Maintained general fitness	61.4%	54.2%
Other	3.5%	5.6%

The performance of resistance exercises was common in both groups of wildland firefighters surveyed. The analysis of the responses obtained revealed no significant differences ($p < 0.05$) between the groups (Table 7).

Table 7. Responses to resistance exercise questions.

Question	Response	Hand crew	Engine crew
Months before fire season?	<1	3.5%	9.4%
	1-3	21.1%	17.9%
	3-6	24.6%	25.2%
	>6	36.8%	53.3%
Sessions per week?	1-2	8.8%	24.5%
	3-5	57.9%	50.0%
	>5	22.8%	14.2%
Minutes per session?	<30	7.0%	18.9%
	30-60	43.9%	47.2%
	>60	38.6%	21.5%
Specific activity performed?	Upper body only	1.8%	16.0%
	Lower body only	0.0%	1.9%
	Core only	1.8%	0.0%
	Upper and lower body	5.3%	1.9%
	Lower body and core	1.8%	0.0%
	Upper body and core	15.8%	10.4%
	All three	61.4%	55.1%

The administration of the questionnaire resulted in significant differences for cardiovascular exercises. Significant between group differences ($p < 0.05$) were found for frequency (sessions per week) and for duration (minutes per session) of cardiovascular training (Table 8). These differences lacked practical significance due to low Cramer's V coefficients of 0.27 and 0.25 respectively.

Table 8. Responses to cardiovascular exercise questions.

Question	Response	Hand crew	Engine crew
Months before fire season?	<1	8.8%	8.5%
	1-3	15.8%	28.3%
	3-6	31.6%	29.2%
	>6	42.1%	30.2%
Sessions per week?*†	1-2	8.8%	30.2%
	3-5	54.4%	48.1%
	>5	35.1%	18.9%
Minutes per session?‡§	<30	5.3%	21.7%
	30-60	63.2%	60.4%
	>60	29.8%	15.1%
Specific activity performed?	Individual	77.2%	66.0%
	Team	0.0%	3.9%
	Both	19.3%	24.5%

* Statistically significant ($p = .003$)

† Practically non-significant, Cramer's V = 0.27

‡ Statistically significant ($p = .006$)

§ Practically non-significant, Cramer's V = 0.25

Both groups of wildland firefighters performed flexibility and stretching exercises as a regular part of their workout routine. The differences between the two groups were not significant ($p > 0.05$) (Table 9).

Table 9. Responses to flexibility and stretching questions.

Question	Response	Hand crew	Engine crew
When performed?	Before activity	8.8%	22.6%
	After activity	10.5%	7.5%
	Before and after activity	70.2%	55.7%
Times per week?	1-2	7.0%	14.2%
	3-5	49.1%	52.9%
	>5	33.3%	18.9%
Specific activity performed?	Martial arts, yoga, or similar	7.0%	9.4%
	Specific routine	49.1%	54.7%
	Both	8.8%	2.8%

The two classifications of wildland firefighters demonstrated similar responses for their estimated current fitness level (Table 10). This similarity made the group differences non-significant ($p < 0.05$).

Table 10. Responses to estimated current physical fitness level question.

Response	Hand crew	Engine crew
Poor	0.0%	0.9%
Below average	3.5%	0.9%
Average	12.3%	33.0%
Good	50.9%	51.9%
Excellent	33.3%	13.2%

DISCUSSION

The purpose of this descriptive study was to assess the pre-fire season physical fitness training among BLM wildland firefighters. An attempt was made to determine what differences existed between wildland firefighter classifications in respect to type and amount of pre-fire season exercise involvement, level of motivation to exercise, and estimated current fitness level. This study included all classifications of wildland firefighters commonly seen on the fire line, specifically smokejumpers, hotshot crew members, hand crew members, helitack, and those working on engine crews. No research has been conducted previously to make this assessment.

Percentage of Agreement

The percentage of agreement statistic is the nonparametric equivalent of the intraclass correlation coefficient for the determination of test-retest reliability. Administration of the questionnaire to 26 subjects on two separate occasions revealed varied percentages of agreement. Eight of the 19 questions asked had percentage of agreement values of less than 80% (Table 3). Several different explanations are possible for these values. The lowest values were for total minutes per week performing resistance exercises (46.2%) and for total minutes per week performing cardiovascular exercises (38.5%). Both of the questions are open ended, allowing for any number of responses, thus a greater potential for variability in scores. In the future, providing specific choices may help to alleviate this problem. For the purposes of this study, the data obtained from these two questions were not used for analysis.

Both resistance and cardiovascular exercises had percentages of agreement values of 61.5% and 73.1% for months before fire season (Table 3). One possible explanation for the low agreement is the overlapping of response choices. Wildland firefighters were able to

choose either "1-3 months" or "3-6 months" as a response. If the wildland firefighter had exercised for three months prior to the beginning of fire season, checking either response would be simultaneously correct and problematic.

Asking the 26 wildland firefighters concerning specific resistance exercises performed resulted in a percent of agreement score of 69.2% (Table 3). The question concerning specific exercises has a possibility of seven different combinations of the responses. Similarly, percent of agreement values for times per week performing resistance exercises (76.9%), times per week performing flexibility/stretching exercises (69.2%), and duration of resistance exercise workouts (76.9%) also had multiple possible responses (Table 3). Perhaps the total number of responses became problematic from a test-retest perspective. Regardless of the actual reasons for the variability of scores, the percentage of agreement values indicated that the content and organization of the questionnaire would need to be revised prior to using the questionnaire in the future.

Questionnaire Distribution

Seven of the 11 groups recruited (64%) participated in the study and returned completed questionnaires (Table 4). None of the crews recruited in Nevada responded. The lack of participation from Nevada can be attributed to several different factors. Timing of questionnaire distribution could have been problematic. Most crews are busy with the training of their wildland firefighters in early June if their fire season has not already begun. Additionally, permission was not obtained specifically from the fire management officer for the State of Nevada. Obtaining only the signature of the state fire management officer for the State of Utah was sufficient for recruitment of wildland firefighters within the Great Basin Region, according to the National Safety Officer working within the National Interagency

Fire Center. Seeing the Nevada state fire management officer's signature on the letter of recruitment may have encouraged more of the Nevada crews to respond.

The two districts in Idaho are comprised of eight field offices. In both Idaho districts the questionnaires were handed out at an all-employees meeting where the wildland firefighters were told to return the questionnaires to a common collection point, within the district office, at their convenience. The majority of the wildland firefighters work at the field offices away from the district office, making the collection of the questionnaires problematic. More than half ($N = 175$) of the wildland firefighters in the subject pool worked on these two districts.

From the subject pool of 317 wildland firefighters, 176 responded, yielding a 56% response rate. Due to the nature of how the questionnaires were categorized upon receipt, there is no way to know how many questionnaires were returned from each individual district and field office. This study was purposely designed in this manner to preserve the anonymity of the respondents. In the future we will code the questionnaires according to district and field office affiliation to make follow-up easier and the comparison of the data obtained more meaningful.

One possible way to resolve the problems associated with the questionnaire distribution would be to send the questionnaire out with the pre-employment paperwork. Distribution in this manner would ensure the completion of the questionnaire from virtually every wildland firefighter hired. Completing the questionnaire would become a requirement for employment, but may encourage dishonesty because the future employer would see the responses.

Wildland Firefighter Demographics

The two classifications of wildland firefighters studied were very similar from a descriptive perspective. On average the hand crew wildland firefighters were older and had more experience than the engine crew members (Table 5). This is not surprising due to the more specialized nature of the wildland firefighters within the hand crew classification, namely smokejumpers and hotshot crew members.

The majority of the wildland firefighters (61.4% of hand crew members and 54.2% of engine crew members) surveyed chose "maintenance of general fitness" as their motivation to exercise (Table 6). Interestingly, only 8.8% of hand crew members and 4.7% of engine crew members identified "recommendation from their present employer" as their reason for exercising. Since the question was not limited to one response, we can assume that wildland firefighters are not given information as to how to most appropriately prepare for the demands of the profession. As part of the pre-fire season information packet, every wildland firefighter should be given information on how to train for the pack test. The federal government has developed a brochure that contains all of this information,⁴ but in our experience, the brochure is not frequently disseminated.

Concerning type and amount of pre-fire season exercise involvement, both classifications were similar (Tables 7 and 8). Because the majority of both classifications maintained general fitness throughout the year, it was not surprising that 36.8% of hand crew members and 53.3% of engine crew members initiated resistance exercise programs and 42.1% of hand crew members and 30.3% of engine crew member initiated cardiovascular exercise programs more than six months before the fire season began. The highest percentages of wildland firefighters performed resistance and cardiovascular exercises three

to five times per week, averaging 30-60 minutes per session. A specific routine implemented three to five times per week was noted most regularly by both classifications for flexibility and stretching as well (Table 9).

Taking all of the data obtained from the questionnaire administration into consideration, 50.9% of hand crew members and 51.9% of engine crew members considered their current physical fitness level as good (Table 10). Interestingly, the second highest percentages (33.3% of hand crew members considered their current fitness level as excellent, 33.0% of engine crew members considered themselves as average) were on the opposite end of the spectrum. There is a certain amount of swagger that comes with being a smokejumper or hotshot crew member which may account for their self-classification as excellent. We believe the difference in current physical fitness estimates between our two groups can be attributed to the additional physical fitness requirements of the smokejumpers and hotshot crew members.

Fitness/Activity Levels

Collapsing the seven wildland firefighter classifications into two groups aided in the answering of the research question. We set out to determine what differences exist between wildland firefighter classifications in respect to type and amount of pre-fire season exercise involvement, level of motivation to exercise, and estimated current fitness level. Our results suggest that the two wildland firefighter classifications did not differ from one another in terms of fitness levels. This may be for a few different reasons.

First, the population studied was comprised of only BLM employees. One may argue that the pool of wildland firefighters employed by the BLM is on a higher level due to the limited number of individuals hired. By employing fewer wildland firefighters, the BLM can

be more selective in their hiring, thus creating a more homogeneous labor force. The homogeneity of the labor force was demonstrated by the similarity in the demographic data discussed previously.

Second, the questionnaire may have lacked the sensitivity to identify differences in type and amount of pre-fire season exercise involvement, level of motivation to exercise, and estimated current fitness level between the two wildland firefighter classifications. While written at an eighth-grade reading level, on numerous occasions the responses on our questionnaire did not make sense. For example, one wildland firefighter reported performing cardiovascular exercise greater than 5 times each week for 30 to 60 minutes each session, but reported performing only 120 minutes of cardiovascular exercise for the week.

Third, many of the questions on the survey were open ended, allowing an unlimited range of responses. As a result, the responses to many of the questions could not be analyzed using the Chi-squared contingency coefficient. In the future, limiting the responses to a certain number may detract from the specificity of the question, but this change would improve the capacity for nonparametric statistical analysis.

Lastly, several wildland firefighters left portions of their questionnaires blank. The missing responses contributed to the difficulty of using the Chi-squared contingency coefficient and resulted in many of the tables showing percentages that do not add up to 100%. The format of the questionnaire needs to be revisited in an attempt to eliminate the problems outlined above. One method may be a computerized version where the computations are performed for the wildland firefighter and progression is not allowed until all questions are complete.

Practical Application

All 163 of the questionnaire respondents in this study had passed his/her pack test. Given the manner in which the questionnaire was administered, the 100% pass rate is understandable. We were not privy to the number of individuals who were hired but subsequently released from employment because of their inability to pass the pack test. Regardless, the question arises, if all who take the pack test pass, is the current test adequate to assess the ability to perform the labors of a wildland firefighter? The results from this study indicated that wildland firefighters prepared to meet the demands of the profession very differently. No matter how they prepared, they were still able to pass the established standard for employment. One smokejumper responded that the pack test is "a joke." Another smokejumper shared that "because the test is pass/fail, the time obtained is insignificant." The smokejumpers included in this study hold themselves to a higher fitness standard than just being able to complete the pack test. In addition to the pack test, smokejumpers are required to run 2.41 km in less than 11 minutes, complete 7 pull-ups, 25 push-ups, and 45 sit-ups, and carry a 49.9 kg pack 4.83 km in less than 90 minutes.⁴

Wildland firefighters in British Columbia are asked to meet a fitness standard higher than just the pack test. After completing the pack test, British Columbia wildland firefighters must complete the Pump and Hose (PH) Test. This test requires participants to "carry a Wajax Mark III pump [weighing approximately 22.7 kg] a distance of 100 meters, and then are timed to carry rolled hose 300 meters, and drag one end of a charged 3.81 cm hose 200 meters. This test must be completed in less than 4 minutes and 10 seconds."⁹ The additional tests performed by the Great Basin Smokejumpers and the wildland firefighters in British Columbia require more than just the passive carrying of weight as required in the pack test.

Given the physically demanding nature of wildland firefighting, a test must be developed that requires a similar level of exertion to pass.

Future Research

Many areas of future research have been identified by conducting this study. First, the population of interest needs to be expanded to other federal government fire crews, e.g., Forest Service, Bureau of Indian Affairs, National Park Service, as well as private contract fire crews. Second, a more objective measure of wildland firefighter physical fitness needs to be included in the next version of our questionnaire. The time obtained on the pack test was not a sufficiently sensitive determinant of physical fitness level. Numerous respondents noted that the pack test is not a race, knowing at what pace they must walk to complete the test in less than or equal to 45 minutes. There are no rewards or benefits with finishing the pack test in the shortest amount of time. Third, researchers need to take the data obtained from pre-fire season questionnaires and follow a group of wildland firefighters through a season of wildland fire fighting to determine if the pre-season physical fitness training makes a difference in overall job performance. Research has shown that hotshot crews actually detrain during a fire season because they are unable to maintain their exercise program due to long hours on the fire line. Of particular interest is the interaction of physical fitness training and injury occurrence while working as a wildland firefighter. A retrospective study is currently being conducted examining work-to-rest ratio and injury rate. Injury rate as a result of insufficient physical fitness levels has not yet been examined.

Limitations

As with many studies, this study was not without limitations. Due to the nature of survey research, not all questionnaires were returned. Second, the subject population was not

randomly selected, but identified from the knowledge of crew makeup, encompassing all classifications of wildland firefighters. If all federal government agencies were included in the study, complete randomization may have been a possibility. There were several unknowns associated with this study: (a) there was no way to know for certain what type of activities the wildland firefighters performed, and (b) there was no direct measure of how physically fit the wildland firefighter actually was when reporting to work. Because of the inability to require wildland firefighters to exercise and the current method of testing work capacity, these problems will have to continue to be dealt with until the aforementioned conditions change.

Conclusions

For most categories of BLM wildland firefighters, the sole fitness criterion for employment is completion of a 4.83 km field-based hike in ≤ 45 minutes while wearing a 20.4 kg backpack, i.e., the work capacity ("pack") test. While all 163 respondents passed his/her pack test, our results suggest that a wide range of physical fitness levels existed among the wildland firefighters surveyed. Further research is needed to determine if differences exist in pre-fire season training regimens and physical fitness levels between federal government, e.g., BLM, US Forest Service, and private contract fire crews. Groups of wildland firefighters need to be followed throughout a season of wildland firefighting to determine if the different approaches to physical fitness are practically significant. Of particular interest is whether the possible differences in physical fitness levels have an effect on the injury rate of wildland firefighters during a season of wildland firefighting. Wildland firefighters work long and hard to protect our nation's wildlands. Greater effort must be made to help them work as efficiently, effectively, and safely as possible.

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Appendix A

**Assessment of Pre-Fire Season Physical Fitness Training Among
Bureau of Land Management Wildland Firefighters**

Rod A. Harter, PhD, ATC/R and Jeremy R. Hawkins, ATC, CSCS

The protocol for the proposed study must be attached to these forms using the headings and order specified below, with each item identified and addressed separately, or the application review will be delayed. **Use lay language throughout the application.**

- 1. Brief Description.** A brief description (one paragraph) of the significance and objectives of this project in lay terms. Include the intended use for this research (e.g., publication, presentation, program evaluation, etc.).

Over the last five years, 470,109 wildfires burned in the United States, consuming more than 26.9 million acres of private, state, and federal land, costing federal agencies nearly 4.8 billion dollars. During this same time period, 100 wildland firefighter fatalities occurred. Numerous governmental agencies and private contractors employ seasonal wildland firefighters to help combat these fires. The firefighters come from all walks of life, and prepare in various ways for the rigors of the profession. The purpose of this study is to assess pre-fire season physical fitness training among Bureau of Land Management (BLM) wildland firefighters. The results of this study will be used to determine if a need exists to standardize pre-fire season training.

- 2. Participant Population.** Include a complete description of the participant population.

To adequately assess the nature of the problem, firefighters employed by the BLM during the 2003 fire season will serve as the population of interest. To qualify for participation in this study, subjects must be an employee of the BLM, ages 18 to 65, who will take the work capacity test (pack test). Passing the pack test is a condition of employment for the BLM, and is required prior to participating in any firefighting activities. The target population will be comprised of firefighters who arrive at wildland fires by airplane, helicopter, vehicle, or foot, as well as management personnel. The participant population sought in this study is not restricted to any gender or ethnic group.

- 3. Methods and Procedures.** A description of the methods and procedures to be used during this research project. Outline the chronological sequence of events involving human participants, beginning with recruitment. Forward written copies of all recruitment materials. Include the estimated time commitment for a participant's involvement.

There are two separate parts to this research process: the development of the questionnaire and the distribution of the questionnaire. The development of the questionnaire will utilize the Delphi method. Experts in the field of wildland

firefighting will be contacted to determine a consensus on important issues of pre-fire season physical training. Through subsequent rounds of the Delphi method, the questionnaire will be developed and refined, until an appropriate tool for the assessment of firefighter fitness is developed (See Appendix C).

The final version of the questionnaire and a full description of its intended use were given to Michelle Ryerson-Grett, Safety Manager, Office of Fire and Aviation, United States National Interagency Fire Center. Permission was obtained from Ms. Ryerson-Grett to distribute the questionnaire to BLM firefighters during the 2003 fire season throughout Alaska, California, Idaho, Nevada, Oregon, and Utah (See Appendix D).

Distribution of the questionnaire will be accomplished by the fire management officers of the various BLM districts and field offices of the aforementioned states. A list of these individuals and their addresses will be accessed online. The packet of questionnaires will be accompanied by a letter of recruitment (See Appendix A) outlining the purpose, intended use, and instructions for administration of the questionnaire. The questionnaires will be administered at the time the firefighter takes the pre-employment work capacity test ("pack test"), or in cases when the work capacity test ("pack test") has already been completed, as soon as possible after receipt of the questionnaire. Approximately three weeks after mailing the questionnaires to the various wildland firefighting units, a letter of reminder (See Appendix A) will be sent to all fire management officers who have not returned their packets.

To address the content reliability of the questionnaire, 20 firefighters from the Vernal Utah Field Office will be administered the questionnaire on two separate occasions. Initial administration will take place just prior to the work capacity test ("pack test"). A second administration will take place one week later. Access to recruit the firefighters from Vernal, Utah, to participate in the reliability study was obtained from Enos Herkshan, Fire Operations Specialist for the Vernal Field Office (See Appendix D).

The estimated time commitment for those taking part in this research project is less than five minutes.

4. **Risks.** A description of the risks (if any) to the participants involved in the research and how those risks will be minimized. Please indicate if there are no foreseeable risks to participants.

There are no foreseeable risks to participants.

5. **Benefits.** A description of the benefits (if any) to the participants involved in this research. Please be sure to indicate if there are no direct benefits to the participants.

There are no direct benefits to the participants.

- 6. Compensation.** Include a description of any compensation that will be given to participants. Include details concerning the conditions under which research participants would receive partial payment or no payment at all (e.g., withdrawing early from the study).

There will be no compensation for the participants.

- 7. Informed Consent Process.** A description of the methods and the process by which informed consent will be obtained and documented.

Each questionnaire will have a letter attached to it that outlines the purpose and the intended use of the questionnaire. The content of the letter will describe the important elements of informed consent, specifically the lack of risk, benefits, and compensation. Each participant will be given an opportunity to read the statement and will be allowed to ask questions prior to filling out the questionnaire. The informed consent statement can be detached by the participant and retained for their records if desired (See Appendix B).

Individuals taking part in the content reliability analysis will not receive a different informed consent letter. The researchers believe that being informed of two administrations of the questionnaire, for the purposes of analyzing consistency of responses only, will cause the results to be unreliable. The important elements of informed consent do not change because of the different use of the results.

- 8. Anonymity and Confidentiality.** A description of the method by which anonymity or confidentiality of the participants' identity and information will be maintained.

The identity of the participants in this study will remain confidential. No information will be collected in conjunction with the administration of the questionnaire that can distinguish one participant from another. Results will be reported in a summary manner in such a way that information regarding individual participants will not be presented.

Individuals taking part in the content reliability analysis will receive a code number to write on their questionnaire after the first administration of the questionnaire. They will be asked to write the same code number on the second questionnaire when the second questionnaire is administered. The record of code numbers will be destroyed after the administration of the second questionnaire to protect the anonymity and confidentiality of the participants. The results from this phase of the study will be used for content reliability analysis only, and will not be represented in the results of the overall study.

9. **Attachments.** Applications must include each of the following as applicable to the proposed research.

Recruitment Materials. A copy of *any* advertising (e.g., posters or fliers) that will be used to recruit participants, including verbal announcements or scripts for initial telephone contact.

See Appendix A for letter of recruitment sent to BLM Fire Management Officers and letter of reminder to follow three weeks later.

Informed Consent Information. The informed consent information, *as it will be distributed to potential participants* (i.e., on Departmental letter head, with a one-inch margin at the top of the page for the IRB approval stamp), including parental permission and child assent documents. The informed consent information must include the pertinent items from the "Basic Elements of Informed Consent" and must be in lay language (written at the eighth grade reading level).

See Appendix B for survey cover letter outlining informed consent.

Questionnaire, Survey, Testing Instrument. A copy of any questionnaire, survey, or testing instrument (if any) to be used in this project.

See Appendix C.

Letters of Approval. Written letters of approval from each of the cooperating school, hospital organization, club, or similar type of group (if subjects are obtained through this type of group or organization, a written letter of approval, from an individual authorized to approve such activities is required).

See Appendix D for letter of approval from Office of Fire and Aviation Safety Manager, United States National Interagency Fire Center, and Vernal Field Office Fire Operations Specialist.

Appendix B

June 3, 2003

Dear Wildland Firefighter:

Over the last five years, 470,109 wildfires burned in the United States, consuming more than 26.9 million acres of private, state, and federal land, costing federal agencies nearly 4.8 billion dollars. During this same time period, 100 wildland firefighter fatalities have occurred. Numerous governmental agencies and private contractors employ seasonal wildland firefighters to help combat these fires. The employed firefighters come from all walks of life, and prepare in various ways for the rigors of the profession.

As a fellow wildland firefighter for the Bureau of Land Management, I am asking for your help in determining the amount of physical fitness training that you performed in the last 6 months to prepare for the 2003 season of wildland fire fighting. I would appreciate it if you would take about 5 minutes to respond to the attached questionnaire and return it to the person you received it from. Your responses, together with others, will be combined and used for statistical summaries only. **Your participation in this study is voluntary and you may refuse to answer any question.** Bureau of Land Management wildland firefighters make up an integral part of the wildland firefighter community, so your participation is vital to the study.

The answers you provide will be kept confidential. No information will be collected as part of the questionnaire to distinguish you from another firefighter. Results will be reported as a summary, in such a way that you cannot be identified. There are no foreseeable risks to you as a participant in this project; nor will you be compensated. There is no direct personal benefit for participating in this study. However, we anticipate that future firefighters may benefit from the results this study, making your participation extremely valuable.

If you have any questions about the questionnaire, please contact me by e-mail at hawkijer@onid.orst.edu. My advisor, Rod A. Harter, Associate Professor, can be reached at (541) 737-6801 or by e-mail at rod.harter@oregonstate.edu. If you have questions about your rights as a participant in this research project, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator at (541) 737-3437 or by e-mail at IRB@oregonstate.edu.

Thank you for your help. We appreciate your cooperation.

Sincerely,

Jeremy Hawkins, ATC, CSCS
Engine Module Leader, Vernal Utah Field Office
Master of Science degree candidate

Rod A. Harter, PhD, ATC/R
Associate Professor

Appendix C

June 3, 2003

Dear Fire Management Officer:

Over the last five years, 470,109 wildfires burned in the United States, consuming more than 26.9 million acres of private, state, and federal land, costing federal agencies nearly 4.8 billion dollars. During this same time period, 100 wildland firefighter fatalities have occurred. Questions continually arise concerning how we can more safely and efficiently combat the destructive nature of these wildfires. As a wildland firefighter and graduate student, one question of particular interest to me is the level of physical fitness that firefighters achieve prior to the start of fire season. For this reason I seek your assistance.

I have enclosed a brief questionnaire concerning the amount and type of pre-fire season physical fitness training that firefighters have completed. Authorization has been obtained from Sheldon Wimmer, Utah State Fire Management Officer, to distribute the questionnaire throughout the Great Basin region. The questionnaire was developed in consultation with fire personnel within the Bureau of Land Management. Please distribute these questionnaires to each of your wildland firefighters at the time of taking the pack test. If there are those on your crews who have already taken the pack test, please have them fill out the questionnaire at their earliest possible convenience. The completion of the questionnaire should take no longer than 5 minutes. The purpose of the questionnaire is to assess how much pre-fire season physical fitness training is currently taking place on the various types of fire crews, from smokejumpers to management personnel. The information obtained from the questionnaire will be kept confidential and anonymous, as there is no identifying information requested. The firefighters will not be compensated for filling out the form, but I believe that in the long run we as firefighters will benefit from the information obtained.

After completing the questionnaire, please return them via the self-addressed, stamped envelope to: Jeremy Hawkins, 3289 W. 1800 S., Vernal, UT, 84078. If you have any questions please contact me by e-mail at hawkijer@onid.orst.edu, or Rod A. Harter, Associate Professor at (541) 737-6801 or by e-mail at rod.harter@oregonstate.edu. If you have questions about your rights as a participant in this research project, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator at (541) 737-3437 or by e-mail at IRB@oregonstate.edu.

Thank you for your willingness to take part in this study. I look forward to receiving your responses.

Sincerely,

Jeremy Hawkins, ATC, CSCS
Engine Module Leader, Vernal Utah Field Office
Master of Science degree candidate

Rod A. Harter, PhD, ATC/R
Associate Professor

Appendix D

June 23, 2003

Dear Fire Personnel:

On June 3, 2003, I mailed a questionnaire to you to be distributed to the firefighters on your district. The questionnaire focuses on the physical fitness training that your firefighters participated in prior to reporting to work. This information is to be used to gain a greater understanding as to the type and quantity of pre-season physical conditioning we do.

At the present time, I have not received your information. If you have returned the questionnaires while this letter was in route, please disregard this correspondence. If you have not yet returned the questionnaires, please do so at your earliest possible convenience. The information obtained from the questionnaire is thought to be very valuable, particularly with the health and welfare of firefighters in mind.

Thank you for your willingness to help with this project. If you have any questions, please do not hesitate to contact me at hawkijer@onid.orst.edu, or Rod A. Harter, Associate Professor, at (541) 737-6801, or by e-mail at rod.harter@oregonstate.edu. If you have questions about your rights as a participant in this research project, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator at (541) 737-3437 or by e-mail at IRB@oregonstate.edu.

Thank you again for your time and consideration. I look forward to hearing from you soon.

Sincerely,

Jeremy Hawkins, ATC, CSCS
Engine Module Leader, Vernal Utah Field Office
Master of Science degree candidate

Rod A. Harter, PhD, ATC/R
Associate Professor

Appendix E

Wildland Firefighter Physical Fitness Preparation

Please take a few minutes to fill out this brief questionnaire regarding your physical fitness preparation for the 2003 fire season. Thank you for your time and participation.

Demographic information:

Sex: Male Female Age _____ Height _____ Weight _____

1. Firefighting experience:

Job description for 2003 fire season:

- Smokejumper Hotshot (type I crew) Hand crew (type II crew)
 Helitack Engine Management Other (specify): _____

Job description for 2002 fire season:

- Not employed as a wildland firefighter
 Smokejumper Hotshot (type I crew) Hand crew (type II crew)
 Helitack Engine Management Other (specify): _____

Total seasons of firefighting experience: _____ seasons of experience

2. What motivated you to exercise in preparation for the 2003 fire season? (check most appropriate response):

- Did not engage in specific activities to prepare for this fire season
 Previous firefighting experience
 Recommendation from another firefighter
 Recommended by present employer
 Maintained general fitness throughout the year
 Other (specify): _____

3. Please describe the fitness activities you performed in preparation for the 2003 fire season.

Resistance exercise:

Yes No

Length of time (months) before season training began: <1 1-3 3-6 >6

Times per week: 1-2 3-5 >5

Typical duration of each workout (minutes): <30 30-60 >60

Estimated total minutes per week spent performing resistance exercises: _____ minutes

Specific activities performed: Upper body Lower body Core (abs/trunk)

Cardiovascular exercise:

Yes No

Length of time (months) before season training began: <1 1-3 3-6 >6

Times per week: 1-2 3-5 >5

Typical duration of each workout (minutes): <30 30-60 >60

Estimated total minutes per week spent performing cardiovascular exercises: _____ minutes

Specific activities performed: individual (running, cycling, swimming, racquetball, etc.)

team (basketball, soccer, volleyball, etc.)

Flexibility/Stretching:

Yes No

When performed: Before activity After activity Before and after activity

Times per week: 1-2 3-5 >5

Specific activities performed: martial arts, yoga, or similar specific routine

4. Estimated time you think you will obtain on the pack test: _____ (round to nearest minute)

Actual pack test time obtained for 2003: (if known) _____ (round to nearest minute)

5. Please estimate your current level of physical fitness based upon your preparations for the 2003 fire season (check most appropriate response):

Excellent Good Average Below Average Poor

Appendix F

The history of wildland firefighting is a storied one. Accounts are told by retired sawmill workers who would leave their sawmill to fight forest fires, in an attempt to protect the forests that were their livelihood. The profession has come far since that time. Now firefighters must participate in training courses and meet medical¹³ and physical fitness standards in order to be on the fire line. The physical fitness standards change dependant upon agency and wildland firefighter job classification. All United States federal and state agencies require fire line firefighters to pass the pack test at the "arduous" level.⁴ In addition to the pack test, smokejumpers are required to run 2.4 km in less than 11 minutes, complete 7 pull-ups, 25 push-ups, and 45 sit-ups, and carry a 49.9 kg pack 4.8 km in less than 90 minutes.⁴ Wildland firefighters in British Columbia are also asked to meet a standard higher than just the pack test. After completing the pack test, British Columbia firefighters must complete the Pump and Hose (PH) Test. This test requires that participants "carry a Wajax Mark III pump [weighing about 22.7 kg] a distance of 100 meters, and then are timed to carry rolled hose 300 meters, and drag one end of a charged 3.81 cm hose 200 meters. This test must be completed in less than 4 minutes and 10 seconds."⁹ The purpose of performing each of these tests is to ensure that firefighters are able to meet the demands of the profession.

Wildland firefighters face additional hazards. Sharkey observed that, "Exposure to smoke, toxic fumes, and heat – as well as other factors – can threaten an individual's ability to conceive or bear a healthy child."¹⁴ Typical exposures are not sufficient to cause reproductive problems. Sharkey recommends wildland firefighters consult their physicians concerning their reproductive health.

In a separate study, Sharkey¹⁵ found that heart attacks are a major contributor to the total number of wildland firefighting fatalities. From 1910 to 1996, 10% (3.2 deaths per year) of all wildland firefighter fatalities were the result of a heart attack. An important note is that there is no evidence relating wildland firefighting to an increase risk of death from a heart attack. The majority of the deaths occurred in volunteers (42%), who were not required to meet the same work capacity standards as federal wildland firefighters. Regardless of who the employer is, the high incidence of heart attacks adds weight to the need for increased physical fitness.

Physical fitness also deals directly with injury rates. The difficult terrain and long hours take their toll on wildland firefighters. Statistics from a representative example of fires in 2002 revealed that 25,864 medic unit visits resulted in 2422 musculoskeletal injuries, representing 9.4% of the total injuries. Of these musculoskeletal injuries, 13.4% were ankle injuries, 18.2% were knee injuries, 47.5% were sore muscles and joints, and 14.9% were low back pain. Thirteen of the fourteen fires reported back pain and injuries to the ankle and knee. All fourteen fires reported sore muscles and joints. The highest incidence of these reports came during the two-month Biscuit Fire in southern Oregon, totaling 183 ankle injuries, 230 knee injuries, 467 cases of sore muscles and joints, and 175 cases of back pain.¹⁶ Similar statistics were found for 2001 medic unit visits.¹⁷ Mangan believed that all injuries can be grouped into four main classifications, "vehicle accidents; tool use; slips, trips, and falls; and muscle strains."³ Mangan also stated that "by inference, several of these injury areas can be related back to the causal factors of fitness levels and fatigue."³

Key to the understanding of the scope of the problem in wildland firefighters is a comparison to an occupation that many are more familiar with, structure firefighters. Similar to wildland firefighters, structural firefighters also have a high incidence of heart attacks. According to the United States Fire Administration (USFA) Firefighter Fatality Retrospective Study 1990-2000, heart attacks were the leading cause of deaths while on duty.¹⁸ KcKeown's main conclusion was that physical fitness is lacking in many structural firefighters.¹⁸ The report from the USFA supports two reports from the 1980's which came to the same conclusion: higher levels of physical fitness will help to decrease the number of heart related deaths among firefighters.^{19,20}

Many researchers have conducted studies with the intent to establish the need for medical and physical standards.²¹ Saupe, Sothman, and Jasenof observed in firefighters ages 40-45, 50-55, and 60-65 that all three age groups were "below the lowest published recommendations for maximal aerobic capacity."²² Saupe et al. concluded that their findings underscored the need to create minimum health and physical performance levels in firefighters.²²

Because of the established need for increased physical fitness, many researchers have implemented exercise training programs and studied their results. Roberts and associates²³ found that after participating in a 16-week fitness program, recruits who did not have an aerobic capacity capable of performing fire suppression duties were then able to do so. Hilyer et al.²⁴ concluded that initiating a flexibility program did not decrease the incidence of injury, but decreased the amount of lost time that was a result of that injury. Pipes²⁵ determined that a program involving interval running and circuit weight training was able to increase the physical performance capacities of the recruits. Ellam et

al.^{26,27} also discovered that physical fitness is related to performance on fire suppression tasks. Obermeyer, Harshaw, and Ellis took their study a step further. Performance tests were conducted prior to the initiation of a 10-week training program. These researchers found that not only did fitness levels improve, so did scores on performance tests.²⁸

Statistics concerning structural firefighter injuries are available from the National Fire Protection Agency (NFPA). Each year, the NFPA surveys a sample of fire departments in the United States to make national projections. The sample is stratified by the size of the community protected. Once an injury has occurred, the NFPA sends a form to the department to request information.²⁹ The injury is classified under two different categories: fireground and nonfireground. Fireground activities are "all activities that firefighters engage in from the moment they arrive at a fire scene to moment they leave, including set-up, extinguishment, and overhaul."²⁹ Nonfireground activities include "responding to or returning from an incident, non-fire emergency (rescue calls, hazardous calls, and natural disaster calls), training, and other on-duty (inspection and maintenance) activities."²⁹ An injury is also defined as "physical damage suffered by a person that requires, or should require, treatment by a practitioner of medicine, such as a physician, nurse, paramedic, or EMT within one year of the incident regardless of whether treatment was actually received, or that results in at least one day of restricted activity immediately following the incident."²⁹

The data for each year from 1996 to 2000 remained consistent. According to the work by Karter and Badger^{29,30} and Karter and LeBlanc,³¹⁻³³ the highest percent of estimated fireground injuries were due to strains and sprains. The estimated percentages fluctuated from 38.1% in 1997 to 45.3% in 2000, with a five year average of 40.9%.

Similar results were witnessed in nonfireground injuries. In 2000, nonfireground strains, sprains, and muscle pain made up an estimated 56.1% of the total nonfireground injuries. During this five year period strains, sprains, and muscle pain averaged 53.3% of the total nonfireground injuries.

The professions of structure firefighters and wildland firefighters are very similar. Firefighters report to work with varying skill and physical fitness levels. Some firefighters must pass fitness tests for employment, others do not. Both professions face hazards, and in the process of performing their duties, firefighters often get hurt. The potential relationship of physical fitness and injury has not been studied. Studies of this time are needed.

Appendix G

FFClass	Sex	Age	Height (m)	Weight (kg)	Yrs Exp	Mot to Ex	Res Ex	Len bef	Times/wk	Duration	Tot min/wk	Spec Act	Car Ex	Len bef	Times/wk	Duration	Total min/wk	Spec Act	Flex/Stre	When	Times/wk	Spec Act	Est Pack	Cur Level	BMI
1	1	25	1.68	83.92	7	4	1	3	3	3	300	7	1	3	3	3	150	1	0			40.00	4	23.74	
1	1				11	4	1	4	3	3	540	7	1	4	3	3	540	1	1	3	3	2	40.00	4	
1	1	33	1.83	79.38	14	4	1	4	2	3	240	7	1	4	2	3	240	1	1	2	2	40.00	5	23.70	
1	1	35	1.83	80.74		4	1	4	3	3	180	7	1	4	3	3	180	1	1	3	3	2	44.00	3	24.11
1	1	42	1.93	83.92		4	1	4	2	2	90	7	1	4	3	2	400	3	1	3	2	2	44.00	5	22.53
1	1	42	1.70	71.67	22	4	0						1	3	2	2	300	1	1	2	2	44.00	3	24.80	
1	1	32	1.78	74.84	13	4	1	3	2	2	240	7	1	3	2	2	175	1	1	3	2	38.00	5	23.62	
1	1	33				1	1	3	2	3	180	7	1	3	2	2	180	1	1	2	2	2	44.00	4	
1	1	31	1.73	72.58	9	4	1	4	3	3	400	7	1	4	2	2	280	1	1	3	2	2	41.00	5	24.25
1	1					4	1	4	2	3	120	7	1	3	2	2	90	1	1	3	3	2	44.55	4	
1	1	29	1.88	80.74	10	4	1	1	2	3	300	4	1	1	2	2	300	1	1	2	2	2	40.00	4	22.84
1	1	35	1.65	72.57	9	4	1	4	3	3	450	7	1	4	3	3	400	1	1	3	2	2	44.00	5	26.66
1	1	50	1.78	77.11	31	5	1	4	2	1	120	7	1	4	2	2	150	1	1	3	2	2	44.00	4	24.34
1		26	1.85	86.18	6	3	1	4	2	2	240	7	1	4	2	2	100	1	0			42.00	5	25.18	
1	1	27	1.88	81.65	9	4	1	2	2	2	180		1	2	2	2	180	1	1	3	2	40.00	4	23.10	
1	1	42	1.73	68.04	24	4	1		2	2	100	7	1	3	2	2	160	1	0			40.00	4	22.73	
1	1	28	1.83	77.11	9	4	1	3	2	2	120	6	1	3	2	2	100	1	1	3	2	1,2	37.00	4	23.03
1	1				20	5	1	3	2	3	180	7	1	3	2	2	180	1	1	1	3		44.00	2	
1	1	36	1.73	70.31	21	4	1	4	1	2		5	1	4	2	2	180	1	1	3	2		44.00	4	23.49
1	1	36	1.78	77.11	19	3	1	3	3	3	45	6	1	4	3	2	40	1	1	3	2	2	41.00	4.5	24.34
1	1	22	1.88	83.92	4	1	1	4	3	3	480	7	1	4	3	2	360	1	1	3	3	2	41.00	4	23.74
2	1	36	1.80	79.38		4	1		3	2	90	7	1	4	2	2	250	1	1	3	3	44.58	5	24.50	
2	1	24	1.80	68.04	0	4	1	3	2	2	45	6	1	3	1	3	120	1	1	3	1	2	38.00	4	21.00
2	1	39	1.83	70.76		4	1	2	1	2	120	7	1	4	3	2	350	1	1	3	3	2	34.00	4	21.13
2	1	19	1.83	83.92	2	1	0						1	1	2	2	240	1	1	3	2	2	39.00	3	25.06
2	1	22	1.83	83.92	2	3	1	2	2	2	120	6	1	2	2	2	120	3	1	3	2	3	42.00	4	25.06
2	1	22	1.96	83.92	3	4	1	4	3	2	240	7	1	4	3	2	230	3	1	3	3	3	39.30	4	21.85
2	1	26	1.78	77.11	2	4	1	1	2	1	180	6	1	3	3	2		1	1	3	2	42.00	5	24.34	
2	1	27	1.93	92.99	3	4	1	4	3	3	320	7	1	3	2	2	120	1	1	3	3	2	41.00	5	24.96
2	1	28	1.78	81.65	2	4	1	2	2	2	40	3	1	4	2	3	10	1	1		3	1	39.00	4	25.77
2	1	25	1.80	65.77	3	4	1	3	1	2	150	6	1	3	3	3	360	1	1	3	3	2	38.00	5	20.30
2	1	31	1.83	79.38		3	1	3	2	2	100	7	1	4	3	3	350	1	1	3	3	41.00	5	23.70	

FFClass	Sex	Age	Height (m)	Weight (kg)	Yrs Exp	Mot to Ex	Res Ex	Len bef	Times/wk	Duration	Tot min/wk	Spec Act	Car Ex	Len bef	Times/wk	Duration	Total min/wk	Spec Act	Flex/Sire	When	Times/wk	Spec Act	Est Pack	Cur Level	BMI
2	1	26	1.83	97.52	1	1	3	2	2	2	120	7	1	3	2	2	200	3	1	3	2	2	37.00	5	29.12
2	1	25	1.91	83.92	8	2	1	2	2	3	30	1	1	2	2	3	180	1	1	3	2	2	38.00	4	23.00
2	1	33	1.91	95.25	14	4	1	4	1	1	120	7	1	4	3	2	280	1	1	2	2	2	35.00	3	26.11
2	1	24	1.85	86.18		4	1	4	2	3	300	7	1	4	2	3	300	3	1	1	2		39.40	5	25.18
2	0	28	1.68	57.15	1	4	1	2	2	1	120	6	1	4	3	3	350	1	1	3	3	3	41.00	5	20.25
2	0	25	1.73	68.04	4	4	1	4	2	2	90	4	1	4	2	2	180	1	1	3	2		35.00	4	22.73
3	1	21	1.91	70.31	2	4	1	3	2	2		4	1	3	2	2	200	1	1	3	2	2	29.00	5	19.27
3	1	22	1.78	65.77	1	3	1	2	2	2	300	7	1	2	2	1	120	1	1	2	2	2	32.00	4	20.76
3	1	25	1.78	90.72	2	1	0						1	1	1	1	10	1	1	1	1		43.00	3	28.63
3	1	36	1.85	108.86	2	0	0						1	1	1	2	120	1	1	1	1	2	35.40	2	31.81
3	0				3	4	1	2	3	3	360	7	1	2	3	3	360	1	1	3	3	2	40.00	4	
4	1	25	1.80	77.11	1	1	1	2	2	2	180	7	1	2	3	2	180	3	1	3	1	2	34.00	4	23.80
4	1	24	1.85	106.59	0	4	1	4	2	3	420	7	1	1	1	1	60	3	1	3	3	2	37.56	4	31.14
4	1	24	1.73	74.84	3	4	1	4	2	3	180	7	1	3	2	2	180	1	1	3	3	1		5	25.01
4	1	28	1.88	104.33	2	1	1	2	2	2	180	7	1	3	3	2	300	1	1	1	2	2	41.00	4	29.52
4	1	28	1.83	78.02	10	4	1	4	3	3		7	1	4	2	2			1	3	3			4	23.30
4	1	23	1.73	79.38	3	1	1	3	2	3	30	7	1	2	3	3	25	3	1	3		1	42.00	5	26.52
4	1	49	1.83		23	0	0						0						0				31.30	4	
4	1	22	1.80	83.92	3	4	1	2	2	2	150	7	1	4	2	3	250	3	0				40.00	4	25.90
4	1	32	1.70	68.04	14	1	1	4	3	3	60	7	1	4	3	3	60	1	1	3	2	1	44.00	5	23.54
4	0	26	1.83	68.04	4	0	0						1	2	1	2	120	1	1	3	2	2	42.20	3	20.32
4	0	31	1.98	63.50	3	4	1	4	2	2	200	6	1	4	2	2	300	1	1	3	3	3	40.00	4	16.20
4	0	20	1.83	69.40	3	4	1	2	2	2		7	1	2	2	2	100	3	1	3	3		41.00	4	20.72
4	0	29	1.65	65.77	6	1	1	3	1	2	40	6	1	3	2	2	60	1	1	3	2	3	39.00	3	24.16
5	1	24	1.83	74.84	1	4	1	3	1	2	90	6	1	2	1	2	90	1	1	3	2	3	36.00	4	22.35
5	1	24	1.75	65.77	4	4	1	3	2	3	300	7	1	2	1	2	120	3	1	3	2	2	40.00	4	21.48
5	1	35	1.75	81.65		4	0	0	0	0	0	0	1	4	2	3	400	1	1	3	2		34.10	4	26.66
5	1	26	1.73	79.38	2	4	1	4	2	3	200	6	1	4	3	3	300	1	1	3	3	1	32.00	4	26.52
5	1	20	1.78	72.58	0	2	1	3	2	2	150	7	1	3	2	2	150	3	1	3	2	2	39.00	4	22.91
5	1	26	1.83	95.25	0	3	1	4	2	2	60	7	1	4	1	2	30	3	1	3	2	2	42.41	4	28.44
5	1	23	1.91	86.18	5	4	0						1	4	3	3	400	1	1	3	3	2	36.00	5	23.62
5	1	24	1.95	88.45	4	4	1	3	2	2	180	7	1	4	3	2	240	1	1	2	3	2	37.00	5	23.26

FFClass	Sex	Age	Height (m)	Weight (kg)	Yrs Exp	Mot to Ex	Res Ex	Len bef	Times/wk	Duration	Tot min/wk	Spec Act	Car Ex	Len bef	Times/wk	Duration	Total min/wk	Spec Act	Flex/Stre	When	Times/wk	Spec Act	Est Pack	Cur Level	BMI
5	1				0	4	0						1	4	1	2	90	1	0				41.00	3	
5	1	19	1.80	72.58	1	1	1	3	2	3	240	6	1	3	2	2	160	1	1	3	2	2	41.00	4	22.40
5	1	33	1.75	79.38	13	4	1	4	2	2	300	7	1	4	2	2	150	1	1	3	2	2	42.00	4	25.92
5	1	21	1.83		3	6	1	1	1	1	30	1	1	1	1	1	30	2	0					3	
5	1	22	1.83	124.74	5	0	1			2			0						0				44.00	4	37.25
5	1	24	1.80	74.84	6	1	1	2	1	2	120	7	1	2	2	1	90	1	1	3	2		41.00	3	23.10
5	1	22	1.85	93.92	0	4	1	2	1	2	180	7	1	4	2	2	180	3	1	3	1	2	41.00	4	27.44
5	1	20	1.75	81.65	3	1	1	2	2	2	120	4	1	1	1	1	60	1	1	3	1	2	43.00	3	26.66
5	1	23	1.70	74.84	0	4	1	4	2	2	280	7	1	2	2	2	180	1	1	3	2	2	41.00	4	25.90
5	1	21	1.88	83.92	3	1	0						1	3	2	3	270	3	0				41.08	3	23.74
5	1	44	1.83	72.58	10	4	1	4	1	1	20	1	1	3	1	1	60	1	1	3	3	2	39.20	3	21.67
5	1	38	1.88	90.72	14	4	1	3	2	3	280	7	1	3	2	2	150	1	1	3	2	2	42.00	4	25.67
5	1	22	1.78	70.31	4	1	1	1	1	1	30	1	1	1	1	2	40	3	1	1	1	2	39.11	3	22.19
5	1	29	1.88	95.25	13	4	1	3	2	2	60	1	1	3	2	2	180	3	1	3	2	2	41.00	4	26.95
5	1	52	1.83	102.06	34	4	0						1	4	2	2	120	1	1	2	2		42.00	3	30.48
5	1	21	1.68	79.38	11	4	1	4	3	3	300	7	1	4	2	2	180	1	1	1	2	2	38.00	4	28.13
5	1	37	1.75	68.04		4	1	3	1	2	90	7	1	3	2	1	90	3	1	3	2		39.00	4	22.22
5	1	21	1.85	108.86	2	5	1	4	2	3	120	7	1	4	3	2	120	1	1	3	3		41.00	4	31.81
5	1	32	1.88	111.13	8	0	0						0						0				44.00	1	31.44
5	1	29	1.91	92.99		4	0						1	4	3	3	540	1	1	2	2	1	25.56	5	25.49
5	1	23	1.83	91.17	2	4	1	4	3	3	300	7	1	4	3	2	180	1	1	1	3	2	39.00	5	27.22
5	1	20	1.83	79.38	2	4	1	4	3	3	600	7	1	4	2	1	90	1	1	3	3		44.45	5	23.70
5	1	26	1.88	95.25	6	0	1	1	1	1	60		1	2	2	2	75	1	1	3	2		45.00	3	26.95
5	1	27	1.80	83.92	11	4	1	1	2	2	95	7	1	1	2	2	225	1	1	2	2	2	34.00	4	25.90
5	1	29	1.91		7	4	1	2	1	1	60	7	1	2	1	2	90	2	0				36.00	4	
5	1	24	1.85	92.99		1	1	4	2	3	500	7	1	2	1	2	120	3	0				38.23	3	27.17
5	1	24	1.85	92.99	3	5	1	3	2	2	180		1	2	1	2	120	1	1	1	1	2	39.00	4	27.17
5	1	23	1.80	79.38	2	4	1	4	3	3	300	7	1	3	2	2	150	1	1	3	2	1	35.42	4	24.50
5	1	19	1.88	90.72	2	4	1	2	3	2	430	2	1	2	2	2	500	1	0				36.00	4	25.67
5	1	24	1.93	99.79	5	4	1	4	1	1	60	6	1	4	3	3	200	1	0				37.00	4	26.79
5	1	31	1.85	81.65	7	5	1	4	1	2	90	7	1	4	2	2		1	1	3	2	2	42.00	4	23.86
5	1	28	1.88	102.06	6	4	1	4	2	3	60	4	1	3	1	2	30	1	1	1	2		39.00	4	28.88

FFClass	Sex	Age	Height (m)	Weight (kg)	Yrs Exp	Mot to Ex	Res Ex	Len bef	Times/wk	Duration	Tot min/wk	Spec Act	Car Ex	Len bef	Times/wk	Duration	Total min/wk	Spec Act	Flex/Stre	When	Times/wk	Spec Act	Est Pack	Cur Level	BMI
5	1	29	1.93	68.04	7	4	1	2	1	1	60	6	1	2	2	90	3	1	3	1	2	44.00	4	18.27	
5	1	25	1.75	86.18	6	1	1		2	1	120		1	2	2	160	1	1	3	2	2	40.25	3	28.14	
5	1	20	1.83	79.38	2	0	0						1	2	1	20	2	1	1			42.00	4	23.70	
5	1	28	1.88	102.06		4	1	4	2	2	250	7	1	2	1	120	1	1	1	2	2	44.00	4	28.88	
5	1	24	1.88	100.70	1	4	1	2	1	1	60	7	1	3	2	2	120	1	1	1	1	2	43.00	3	28.49
5	1	31	1.85	79.38	6	1	1	4	2	3	180	7	1	4	2	2		1	1	3	3	2	41.00	4	23.19
5	1	20	1.78	77.11	2	1	1	2	1	2	200	7	1	2	1	2	200	3	1	3	1		42.00	3	24.34
5	1	34	1.75	77.11	0	4	1	3	2	2	300	7	1	4	3	3	300	1	1	3	2	2	43.00	5	25.18
5	1	26	1.83	79.38	7	4	1	4	3	3	1500	7	1	4	3	3	1500	1	1	3	3	2	41.00	5	23.70
5	1	26	1.78	99.79	6	1	1	2	1	2	90	7	1	2	1	2	90		1	3	1		3	31.50	
5	1	23	1.80	95.25		1	1	1	2	1	120	1	1	2	2	2	150	3	1	1	2	2	36.15	4	29.40
5	1	64	1.78	89.36	3	3	1	4	2	2	120	7	1	4	2	1	80	1	1	3	2	2	44.00	4	28.20
5	1	22	1.80	113.40	0	5	1	1	2	1	90	2	1	1	1	1	60		1	1	2		43.00	2	35.00
5	1	23	1.80	104.33	3	1	1	2	2	2	150	7	1	2	1	1	60	3	1	1	2		40.35	3	32.20
5	1	22	1.83	79.83		4	1	3	2	2	180	7	1	3	1	1	40	1	1	3	1	2	40.40	4	23.84
5	1	20	1.85	68.04	2	1	1	2	2	1	45	1	1	2	2	1	45	3	0				39.00	5	19.88
5	1	23	1.83	95.25		1	1	1	1	1	30	6	1	1	1	2	45	3	0				42.00	3	28.44
5	1	18	1.88	86.18	0	3	1	3	2	3	300	7	1	3	2	3	720	3	1	3	2	2	42.00	4	24.38
5	1	24	1.78	89.81	4	4	1	4	3	2	360	7	1	4	3	2	420		1	3	3	2	40.10	4	28.35
5	1	30	1.83	86.18	9	4	1	4	1		80	7	1	4	2	2	150	1	1	3	1	2	35.00	4	25.73
5	1	24	1.88	95.25	1	2	1	1	1	1	30	7	1	2	2	2	160	1	1	1	2	2	43.00	4	26.95
5	1	24	1.73	72.56	2	4	1	4	3	2	225	7	1	4	2	1	100	1	1	3			43.00	5	24.25
5	1	61	1.80	83.92	15	4	1	4	2		60	7	1	2	3	2	180	1	1	3	2	2	39.00	5	25.90
5	1	29	1.91	83.92	3	0	1	4	2	2	120	7	1	2	3	1		1	1		2	1	38.15	4	23.00
5	1	27	1.67	68.04	3	1	1	3	1	2	60	6	1	3	2	2	90	1	1	1	2		35.00	4	24.40
5	1	37	1.80	74.84	10	1	1	2	1	1	60	1	1	3	2	2	240	1	1	1	2	2	33.00	4	23.10
5	1	25	1.88	81.65	0	0	1	1	2	2	100	1	1	3	1	3	120	2	1	1	2	1	43.00	3	23.10
5	1	18	1.70	63.50	0	4	0						1	3	3	3	400	3	1	1	2	2	36.00	4	21.97
5	1	20	1.80	73.94	1	1	1		1	1	60	1	0						1	3	1	2	42.00	3	22.82
5	1	19	1.80	74.84	1	4	1	4	3	3	600	7	1	2	1	2	120	3	1	1	3	2	40.00	5	23.10
5	1	32	1.65	81.65	1	3	1	2	2	3	120	7	1	2	3	3	120	1	1	3	3	2	42.21	4	29.99
5	1	24	1.80	79.38	5	4	0						1	2	1	1	60	1	1	1	1	1	38.40	3	24.50

FFClass	Sex	Age	Height (m)	Weight (kg)	Yrs Exp	Mot to Ex	Res Ex	Len bef	Times/wk	Duration	Tot min/wk	Spec Act	Car Ex	Len bef	Times/wk	Duration	Total min/wk	Spec Act	Flex/Stre	When	Times/wk	Spec Act	Est Pack	Cur Level	BMI
5	1	23	1.83	70.31	5	1	1	2	2	2	100	7	1	2	2	2	100	1	1	3	2	2	33.00	4	20.99
5	1	18	1.80	104.33	0	4	1	4	2	2	180	7	1	3	1	1	90	3	1	3	2	2	39.00	4	32.20
5	1	47	1.78	79.38	24	1	1	4	2	2	25	7	1	4	2	2	125	1	1	3	2	2	39.50	4	25.05
5	1	23	1.88	102.06	2	4	1	4	2	2	150	7	1	4	1	1	60	1	1	2	2	2	42.00	4	28.88
5	1	23	1.96	86.18	2	4	1	4	2	3	180	6	1	3	2	2	180	3	1	3	2	2	44.00	4	22.43
5	1	27	1.68	70.31	6	2	0						1	2	1	2	90	1	1	3	2	2	39.00	4	24.91
5	1	25	1.80	90.72	4	1	1	3	3	2	208	1	1	3	2	2	200	1	1	3	3	2	40.00	4	28.00
5	1	22	1.75	72.58		4	1	4	2	2	60	1	1	3	2	2	60	1	1	3	2	2	34.32	4	23.70
5	1	25	1.83	102.06	5	4	1	2	2	2	100	7	1	4	2	2	225	1	1	3	2	2	34.00	3	30.48
5	1	37	1.75	86.19	10	4	1	3	1	2	90	7	1	2	1	1	60	1	1	1	1	2	43.00	3	28.14
5	1	21	1.91	77.11	3	4	1	4	3	3	360	1	1	3	1	2	300	1	1	3	3	2	31.00	5	21.14
5	1	19	1.85	77.11	0	4	1	3	3	3	360	7	1	3	3	3	360	3	1	3	3	2	38.00	5	22.53
5	1	21	1.88	79.38	0	4	1	4	2	2	180	6	1	1	1	1	45	3	0				39.00	4	22.46
5	1	24	1.93	113.40	3	1	1	3	2	2	120	1	1	3	2	1	120	1	0				31.00	4	30.44
5	1	18	1.80	63.50	0	1	1	1	1	1	10	1	1	1	1	1	30	3	1	3	1	1	46.00	4	19.60
5	0	20	1.70	68.04	2	4	1	4	3	2	350	7	1	4	3	2	350	3	1	2	2	2	40.00	4	23.54
5	0	19	1.75	70.31	2	4	1	3	2	2		1	1	3	2	2		1	1	3	2	2	37.00	3	22.96
5	0	22	1.83	70.31	1	1	1	3	2	2	90	7	1	3	2	2	240	1	1	1	1	1	37.00	3	20.99
5	0	19	1.60	61.24	0	3	1	2	1	1	60	7	1	3	2	2	225	1	1	2	2	1	38.05	3	23.92
5	0	20	1.65	61.24	3	4	1	3	2	2	45	7	1	4	2	2	45	1	1	3	2	2	35.00	3	22.49
5	0	33	1.56	63.50	12	4	1	3	1	1	30	6	1	3	3	2	60	1	1	2	3	3	40.00	3	26.09
5	0	22	1.68	63.50	4	1	1	3	2	2		7	1	3	2	2		1	1	3	3		41.43	3	22.50
5	0	24	1.85	54.43	7	4	1	4	2	2	90	7	1	4	1	2	60	1	1	3	3	2	44.00	3	19.99
5	0	21	1.75	63.50	0	4	1	4	3	3	540	7	1	4	3	3	540	1	1	3	3	2	37.00	3	20.73
5	0	35	1.75	83.92		4	1	2	2	3	120	7	1	2	2	3	120	3	1	1	2	2	41.00	3	27.40
5	0	30	1.70	73.94	2	5	1	2	2	2	90	7	1	2	2	2	90	1	1	1	2	2	42.00	3	25.58
5	0	44	1.73	77.11	3	4	1	3	2	2	180	6	1	2	2	2	180	1	1	1	2	2	44.00	3	25.76
5	0	23	1.73	66.68	2	0	1	3	2	1	30	1	1	3	2	2		1	1	3	2	1	35.00	3	22.28
5	0	21	1.60	49.90	2	4	1	3	2	2	90	7	1	3	2	2	90	1	1	3	2	3	43.15	4	19.49
5	0	21	1.60	52.16	2	1	1	3	2	2	180	7	1	1	1	1	40	1	1	3	2	1	42.00	4	20.38
5	0	23	1.85	61.24	1	4	1	4	2	2	180	7	1	4	3	2	180	1	1	3	3	2	39.00	5	22.49
6	1	26	1.78	102.06	7	4	1	4	3	3	120	6	1	2	2	2	240	1	1	3	3	2	42.15	3	32.21

FFClass	Sex	Age	Height (m)	Weight (kg)	Yrs Exp	Mot to Ex	Res Ex	Len bef	Times/wk	Duration	Tot min/wk	Spec Act	Car Ex	Len bef	Times/wk	Duration	Total min/wk	Spec Act	Flex/Stre	When	Times/wk	Spec Act	Est Pack	Cur Level	BMI
6	1	37	1.78	72.58	12	4	1	3	2	2	120	7	1	3	2	2	120	1	1	3	2	2	45.00	3	22.91
6	1	36	1.85	88.45	18	4	1	4	1	1	40	7	1	4	1	1	50	1	1	1	1	2	44.00	2	25.84
6	1	37	1.93	133.81	18	4	1	4	1	2	120	7	1	4	1	2	120	1	1	2	1	2	44.59	4	35.92
6	1	35	1.78	83.92	13	4	1	4	2	2	60	1	1	4	2	2	240	3	1	2	2	2	37.15	3	26.49
7	1	46	1.65	72.58	20	4	0						1			2	150	1	1	3	2	2	43.00	5	26.66
7	1	55	1.70	74.84	38	4	1	4	2	2	60		1	4	2	2	100	1	1	3	2	1	43.00	4.5	25.90
7	1	22	1.88	104.33	1	3	1	4	2	2		6	1	4	1	2	100	3	1	1	2	1	44.00	3	29.52
7	1	51	1.83	79.38		4	1	4	2	3	200	7	1	4	3	3	360	1	1	3	3	2	41.25	5	23.70
7	1	33	1.83	72.58	14	4	1	3	1	1	60	7	1	4	2	2	220	1	1	1	2			4	21.67
7	1	27	1.68	65.77	2	1	1	1	1	1	60	7	1	2	1	2	120	1	0			42.00	4	23.30	
7	0	30	1.63	68.04	13	1	1	4	3	2	180	7	1	4	3	2	270	1	1	2	3	2	41.00	4	25.61

Q11T1	Q11T2	Q12T1	Q12T2	Q13T1	Q13T2	Q14T1	Q14T2	Q15T1	Q15T2	Q16T1	Q16T2	Q17T1	Q17T2	Q18T1	Q18T2	Q19T1	Q19T2
1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	1	1
1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	0	1	1	1	1	1	0	1	0	1	1	1	1