Using Evidence of Effective Incentives to Enhance Physical Health and Fitness of the Canadian Armed Forces.

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ABSTRACT

Objective/Topic:

· *To develop and implement an individual Fitness profile for each military member to incentivize occupational and health-related physical fitness above and beyond the minimum required for employment*

· *To provide leaders with a continuous metric of their members' physical and health related fitness in order to best design and deliver their health promotion and physical fitness services and programs.*

Since 2013, the Canadian Armed Forces (CAF) have had a field expedient physical employment standard (PES), with four components, which accurately predict job performance on completing the common military tasks required for employment. However, as this is a legally defensible PES, it has a minimum performance standard and assesses employability, a dichotomous variable, not a true indicator of other aspects of fitness. Asking CAF members to achieve only a minimum standard is counter to incentivizing improved performance. Therefore, in 2015 the CAF introduced a tiered incentive program with links to health-related and occupational related fitness, named the "Fitness Profile (FP)".

The 4 elements of the PES, when performed to maximum and converted to a point scale are compared to 8 categories of age and gender norms for the CAF to determine Occupational Performance. In addition, PES scores provide an accurate measure of one's Cardiorespiratory fitness (CRF) or $\dot{V}O_{2max}$*. There is a wealth of research linking low CRF to increased mortality and morbidity and this relationship is independent of age, ethnicity, smoking status, alcohol intake, and health conditions. Therefore, to assess one's "Health related fitness"* $\dot{V}O_{2max}$ *is linked to one's age and gender related risk of morbidity and mortality. In addition, research has identified relationships between the PES,* $\dot{V}O_{2max}$ *and risk of a musculoskeletal injury.*

Fitness Profile results are reported to the chain of command to provide metrics on their members over time. By using these data, commanders are better able to target the appropriate health and fitness programming for their base/wing and identify if there are specific barriers to programs or resources.

Future analysis of these metrics may enable us to determine if there are changes in performance during major events in a member's journey, such as post-partum, post deployment, following rehabilitation of an injury, or even a lifestyle change, which may merit an accommodation or more creativity in designing physical training programs for the individual.

1.0 ADDRESSING THE NEED TO INCENTIVISE HEALTH-RELATED FITNESS

In 2010 The Canadian Armed Forces (CAF) Chief of Defence Staff (CDS) expressed the need to enhance the health and fitness of his members, as evidenced by the results of the 2008/2009 Health and Lifestyle Information Survey which showed that less than half the CAF can be considered physically active (Born et al 2010). A revised Physical Employment Standard (PES), which applies to all CAF members, was implemented in 2013, and with this, the start of collecting PES results on a digital platform for tracking and reporting purposes (FORMeFIT). Given CDS' concern over obesity in the CAF as well as the operational focus of the FORCE Evaluation, the Human Performance Research and Development Cell within the Directorate of Fitness, was directed to examine potential avenues for enhancing and incentivising, while tracking and acting on a broader range of physical fitness components in CAF personnel.

The only basis for taking career action on personnel fitness would remain the Common Military Task Fitness Evaluation, as predicted by the FORCE Evaluation, the annual PES. However, the need for a more general physical fitness profile provides as a basis for counselling individuals and directing them toward appropriate resources (e.g., Health Promotion (HP) programs, DFIT.ca or PSP-led fitness classes) as well as guiding the chain of command in addressing fitness levels in the CAF.

The FORCE evaluation is an evaluation of the CAF members' Operational Fitness Capability, assessed at the minimum level required to complete operational tasks with physical demands. However, it does not capture all of the components of Physical Fitness. The general components of physical fitness are (a) cardiorespiratory endurance, (b) muscular endurance, (c) muscular strength, (d) body composition, and (e) flexibility (Casperson et al, 1985). The annual PES, FORCE (Figure 1), and the minimum standard of operational fitness capture (b) muscle endurance and (c) muscle strength as well as (e) flexibility. FORCE at the minimum standard was neglecting provide an assessment of a members (a) cardiorespiratory endurance (or CRF-Cardiorespiratoy fitness), or (d) body composition, as these were not identified as the limiting components of physical fitness to perform at a minimal operations standard. The Fitness Profile (FP) was developed to incentivise both Operational Fitness (performance on the PES), and Physical fitness.

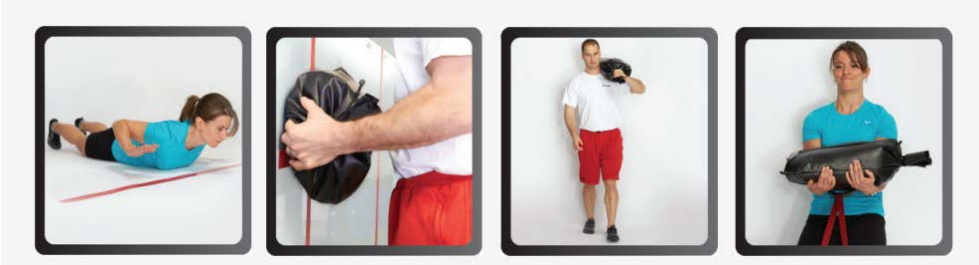

Figure 1: The FORCE Evaluation performed as 20m rushes (20mR), Sandbag Lift (SBL), Intermittent Loaded Shuttle (ILS), and SandBag Drag (SBD).

2.0 THE FITNESS PROFILE: HEALTH RELATED FITNESS

Cardiorespiratory Fitness (CRF) and Body Composition are components of Health related fitness. The mean oxygen cost of performing FORCE at the minimum operational standard was determined through direct measurement to be reasonably low, 26.3 ml O_2/kg21/min (Reilly, 2014), well below accepted thresholds for optimal health (Kodoma et al, 2009). Between 2014-2016 the $\dot{V}O_{2max}$ max FORCE relationship was investigated to see if results on FORCE could accurately predict $\dot{V}O_{2max}$ (Laframboise et al, 2018). Over this period a sample of 248 healthy adults (73 females) aged 17-59 years performed FORCE at maximum effort

and a GXT (a maximal graded exercise treadmill test). As there was no current measure of body composition, height (Ht), weight (Wt), percent body fat, waist circumference (WC), and lean body mass (LBM) were also captured. A linear regression analysis including anthropometrics and demographics (sex and age) identified various models with high predictive ability (R^2 range 0.72-0.76; SEE range 3.82-4.12mL/kg/min). These values are similar to other indirect maximal tests used to predict $\dot{V}O_{2max}$ such as the Cooper tests, a 1.5 mile run and the 12 min run, and the Leger 20m shuttle run. These are commonly used and reliable field tests that yield high prediction accuracy in adults; [1.5 mile run: r = 0.79-0.90 (Grant 1999, George 1993, McNaughton 1998), 12 min run: r = 0.84-0.92 (Jorgensen 2009, Grant 1995, McNaughton 1998, Penry 2011), and 20m shuttle run r = 0.79-0.90 (Leger 1982 1988 1989, Ramsbottom 1988, Grant 1995, Penry 2011, McNaughton 1998)]. The regression equations generated to link FORCE with $\dot{V}O_{2max}$ yielded errors (%SEM) ranging from 8.4 to 9.1%, which fall within the 10% error range accepted for predictive tests (McCardle, 1991). The largest predictive range was +/-2.2 mL/kg/min, which occurs for the low performing females between 25 and 30 years of age. Ultimately, the predictive model selected requires only the ILS FORCE time, WC and gender to predict $\dot{V}O_{2max}$.

2.1 Cardiorespiratory Fitness and All-Cause Mortality

A relatively detailed and wide-ranging review of literature supports the position that CRF and body composition are both independent and significant predictors of mortality and morbidity. A total of 49 studies (including original papers and meta-analyses) were accepted into a literature review performed by Human Performance. The majority of the data reported was based on large-scale longitudinal epidemiological studies which tested various components of fitness and then followed individuals for as many as 35 years. As well, an existing meta-analysis of studies relating CRF to mortality and morbidity served as a starting point to locate additional studies (Kodama, et al., 2009). This review included 33 studies. There were 6910 cases of all-cause mortality in 102 908 participants and 4484 deaths attributed to Coronary heart disease (CHD) and Cardiovascular disease (CVD) in 84 323 participants. Kodoma et al (2009) concluded that better CRF was associated with lower risk of all-cause mortality, CHD and CVD. A 1-MET increase in a person's $\dot{V}O_{2max}$ was approximately associated with a 13% and a 15% risk reduction in all -cause mortality and CHD/CVD, respectively. The relative risk ratio for low fitness versus high fitness was of 1.4 -1.7 for all-cause mortality.

Other militaries linking CRF and health include the US National Guard who employ a 2-mile run and categorize personnel based on a 10-year CHD risk. This was implemented as a result of identifying that their National Guard members were experiencing CVD symptoms despite being screened as low or moderate risk on the Framingham profile (469 cardiac referrals of deployed soldiers with a mean age of 39 years) (Talbot et al., 2009).

The US Air Force developed a scoring system on their fitness test creating a health profile which was determined based on CVD risk, and risk of injury, assessed through a 1.5 mile run, push-ups, sit- ups and abdominal circumference (Baumgartner et al., 2018) This model was also employed to guide the Fitness Profile for the CAF. Similar emergency services such as The Royal National Lifeboat Institution in the United Kingdom (Reilly and Tipton, 2005), and Firefighters in the USA and Canada (Poplin et al., 2014) have an aerobic fitness standard with the intention of improving health, while not always directly linked to the metabolic demands of the job, but more the categorisation of "fit" and "unfit".

At the time of this research project, only self-reported Physical Activity (PA) was collected for the CAF. Through this literature review self-reported PA was found to be inconsistent and inconclusive as an indicator of all-cause mortality (Folgelholm, 2010). When physical activity, physical fitness and possible confounding variables are included in a multivariate model, fitness remains strongly associated with mortality and the association between self-reported activity and health is no longer significant (Blair et al 2001, 2001; Sobolski et al. 1987). Therefore, the use of these zones of low to high risk based on Kadoma's meta-analysis of CRF

were established and implemented in the FP, similar to the USAF (Figure 2, Table 1). As $\dot{V}O_{2max}$ was easily and accurately predicted by the FORCE Evaluation when WC was included, these additional measures would serve to establish a more complete FP of CAF personnel, expanding beyond simply the occupational fitness required to pass the minimum standard. Though no career action could or should be taken on these broader measures of physical fitness, the information would serve to counsel the individual as well as to provide metrics to the chain of command to guide and prioritise program delivery.

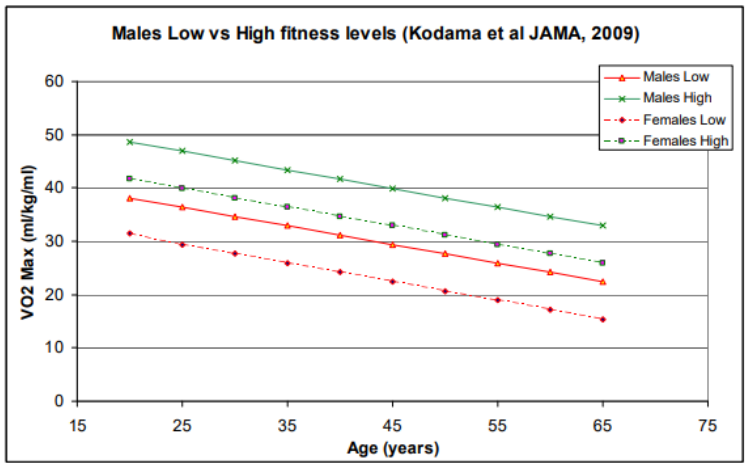

Figure 2. Cut-offs for low and high CRF based on Kodoma et al, 2009.

Table 1. High and low risk cut-offs based on Kodoma et al (2009) (Reilly, 2014).

	VO_2max (mL/kg/min)			
	Male		Female	
	Risk Cut-off			
Age	High	Low	High	Low
15-20	38.1	48.6	31.5	41.7
20-25	36.4	46.9	29.4	39.9
25-30	34.6	45.1	27.6	38.1
30-35	32.9	43.4	25.9	36.4
35-40	31.1	41.6	24.1	34.6
40-45	29.4	39.9	22.4	32.9
45-50	27.6	38.1	20.6	31.1
50-55	25.9	36.4	18.9	29.4
55-60	24.1	34.6	17.1	27.6

2.2 Body Composition

The addition of WC to the PES was hypothesised to be a potential obstacle due to its perceived link with aesthetics, and the personal nature of taking the measure. However, the value of introducing a body composition measure to incentivize health related fitness was first established and communicated to the defence team. Similar research had been conducted within military organisations using body composition to identify health risks. The US National Guard had identified a significant relationship between abdominal circumference (AC) and CVD risk (19 years longitudinal study). A significant positive relationship was observed between AC and 10 year Coronary heart disease risk (men), when controlling for age, and AC established as a predictive variable for a 10 year CHD risk score (Ricciardi et al., 2009). Adiposity and

physical fitness are both important predictors of diabetes, and are independent of several other risk factors (age, smoking, alcohol and parental history) (Katzmarzyk, 2007; Lee et al., 2005; Lee et al., 2009). To identify unfit males at risk for CHD (as assessed by the Framingham Heart Study), WC or AC was determined as the best anthropometric when compared to % Body fat, BMI and Waist to hip ratio (WHR).

In addition, varying medical governing bodies had begun publishing results reinforcing the need to collect WC or AC at the doctor's office (NHLB, 2013; World Health Org., 2011). In fact, the 2006 Canadian Clinical Practice Guidelines on the Management and Prevention of Obesity in Adults and Children indicated AC or WC help to determine a patient's risk profile for CVD and overall health risk, providing a reference point for monitoring AC over time to prevent obesity related diseases. They recommend the creation of a national surveillance system that incorporates at minimum the measurements of height, weight and AC (Lau et al., 2007). To establish risk zones for the CAF cut offs of < 102 cm for men and < 88 cm for women were established, based on findings by the World Health Organization (WHO).

However, to determine if there would be resistance from the CAF on the introduction of a WC measure, a pilot trial of the Fitness Profile, including 624 military participants from 4 military bases/wings was conducted (27% female). Participants performed the annual PES (FORCE) to their volitional maximum, had their WC measured by the fitness instructor or researcher, as well as completed a survey following testing to solicit their opinion on both the Fitness Profile, and the WC measure. Very few recruited participants refused the abdominal circumference measurement and based on their answers on the post evaluation survey, most believed that WC and a debrief on their Fitness Profile score provided a benefit to the evaluation. For example, 4.6% disagreed or did not understand the need to take WC and 5.7% were not comfortable having it taken (Table 2). It was repeatedly made clear to participants that the WC measurement in the FP is in no way linked to any employment condition or policy.

Table 2. Results from the 2017 survey on the introduction fo the FP and WC measurement.

	Agree strongly (%)	Agree moderately (%)	Agree a little (%)	Neither agree nor disagree (%)	Disagree a little (%)	Disagree moderately (%)	Disagree strongly (%)	Do not know or not applicable (%)
Understood reason for taking AC measure	51.0	25.7	11.3	3.5	3.2	0.7	0.7	0.5
Comfortable with having AC measure taken in this way	58.1	21.1	7.3	4.1	2.5	1.7	1.5	0.2
Understood fitness profile result	75.5	13.7	4.6	0.8	0.3	0.2	0.5	0.3
Believed fitness profile result was accurate	48.6	31.1	6.9	1.7	3.4	1.9	1.9	0.5
Plan to make changes to lifestyle based on result	34.6	29.2	14.9	8.4	1.4	2.9	3.9	1.0

2.3.1 The relationship between AC and CRF

In the final model, to predict health-related fitness (morbidity and mortality) WC only accounts for only 25% and $\dot{V}O_{2max}$ the other 75%. This ratio was implemented as, for given levels of abdominal subcutaneous fat, visceral fat or WC, research indicates that men with higher levels of CRF had substantially lower metabolic risk compared with men of low CRF (Lee et al., 2005). Stevens et al. (2002 & 2004) report that both CRF and obesity are independent predictors of mortality and that high fitness substantially ameliorated the risk of obesity but did not eliminate it. The highest risk of mortality was observed in those who are both obese and unfit (Lee et al., 2010). In addition, to this scientific reasoning to place the emphasis on CRF, it was the decision of the organisation to put more importance on incentivising CAF members to increase their fitness, than improve their body composition, potentially through diet alone.

3.0 THE FITNESS PROFILE: OPERATIONAL FITNESS AND HEALTH RELATED FITNESS

Figure 3. The Fitness Profile employed in the CAF incentivisation strategy today. The Veritcal (Y) axis refers to points earned on the FORCE Evaluation and "Occupational Fitness" whereas the Horizontal axis (X) refers to points earned on the $\dot{V}O_{2max}$ prediction (75%) + WC (25%) translated to health related fitness.

Figure 3 is the chart for which a CAF member reviews with a fitness specialist after completing their annual PES. Their result is plotted based on their score on FORCE, considering their WC, given their age and gender category. Within each group, age and gender-specific scores are calculated for each of the four FORCE Evaluation components, wherein each test element is scored on a scale of 100 points, for a total of 400 points on the overall test. Before the 2016 launch, the trial year of 2015 provided Fitness Profile data of over 35,000 FORCE Evaluations performed in the CAF. These data formed the original frequency distributions by gender and 5-year age group. It is important to note at this stage although the incentive program structure was approved by Armed Forces Council (AFC) in February 2015, the logistics of assigning and administering rewards were still being addressed by the Chief of Military Personnel within the CAF, and the rewards themselves were not determined.

After two more years of collecting FORCE data for the Fitness Profile (2016/2017), adjustments were required to ensure the incentive thresholds of the Occupational performance, and norm references categories, reflect the CAF. Electronic data from 109 000 test entries were used to update the normative scoring tables associated with each 5 year age-gender category and determine the upper 50% eligible for the incentive. This revision resulted in more representative categories of the top 34% in Bronze, ~14% in Silver, ~2% in gold, and 0.1% in Platinum. An adverse Impact analysis indicated that females had a 94.6% chance compared to males at attaining each of these categories. Where females were less likely to achieve incentive was in categories of older females where data sets were not complete due to females avoiding testing in large numbers. Also, as females age, one element of the FORCE test seems to decline more than the others creating an imbalance in the scoring.

The tables and figure below (Table 3 and Figure 4) provide an on the spot report of data from 2018. These are the type of analysis the FORMeFIT system allows for, a queryable data based, where incentive results can be instantaneously produced and reviewed based on demographics.

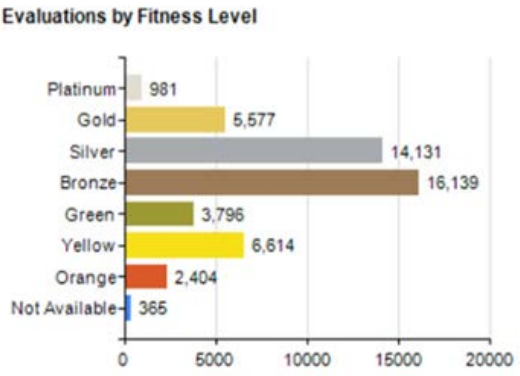

Figure 4. Evaluations by fitness level for 2018, demonstrating the relative numbers is each category.

Table 3. Evaluations by Incentive and Gender

Evaluations by Fitness Level and Gender

Gender	Platinum	Gold	Silver	Bronze	Green	Yellow	Orange	Not Available	Total Evaluations	Average Level
Male	880	5,035	12,427	13,928	2,942	5,632	2,215	184	43,243	Bronze
Female	101	542	1,704	2,211	854	982	189	181	6,764	Bronze

Starting in April 2017, participants who score above average on their Fitness Profile were eligible for the Incentive Program.

Bronze: you have a result better than or equal to 50% of the CAF population group.

Silver: you have a result better than or equal to 84% of the CAF population.

Gold: you have a result better than or equal to 98% of the CAF population.

Platinum: you have a result better than or equal to 99.9% of the CAF population.

Currently, as of 2019, the rewards are monetary, and those in the Silver or above will receive a t-shirt, those in Gold receive a hooded sweatshirt, and those in Platinum receive a hooded sweatshirt and a pin.

4.0 ADRESSING THE NEED TO HAVE A DYNAMIC AND ELECTRONIC REPORTING PLATFORM

The ability to deliver the Fitness Profile hinged on one major evolution regarding how we evaluate CAF personnel on their annual PES. These evaluations needed to be captured electronically so that a CAF members FP could be reviewed with them instantly after the test (Figure 5), thereby providing an individual with information to empower change, and direct them to the appropriate resources. In addition, the electronic fitness platform (FORMeFIT) would allow for quarterly reporting on fitness and health-related fitness metrics to their Chain of Command (CoC).

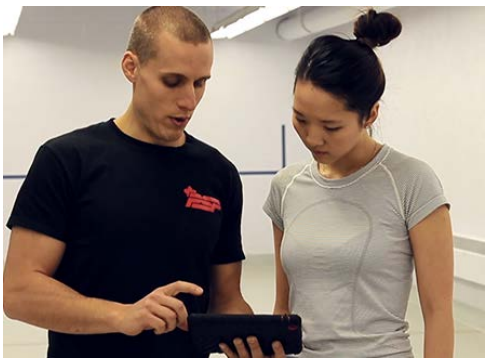

Figure 5. Fitness staff for PSP reviewing a CAF members Fitness Profile (FP) directly after she completes her FORCE evaluation.

An impetus for the need to collect and report these metrics on the CAF was identified by the Assistant Deputy Minister (Review Services) (ADM(RS)) audit in 2014 of the 2008 CAF Health and Physical Fitness Strategy. This review highlighted the requirement for a more robust performance measure and reporting mechanism relating to health and fitness in the CAF. Therefore, the evolution to the FORMeFIT System addressed that requirement by providing efficient means of tracking and reporting of evaluation results.

A risk analysis was performed considering the privacy/legal concerns of collecting personal data on CAF members and reporting these data within their CoC. Three working groups were established including members from Clinical Council (Surgeon General), the office of the Judge Advocate General (JAG), DND/CF Legal Advisors (DND/CF LA), Director Health Services Delivery (DHSD), and Director Access to Information Privacy (DAIP). The three areas addressed in these consultations were (1) respecting data privacy (2) providing the correct framework for commanding officers (COs) to interpret the FP data they receive on their subordinates, and (3) ensuring that the results complement and do not contraindicate those from Health Services.

4.1 Collecting and storing personal information

The collection and storage of any personal data by the federal government is a tightly regulated process. A Privacy Impact Assessment was conducted in collaboration with the Director of Access to Information Privacy (DAIP) in order to ensure that all regulations were adhered to. A Personal Information Bank (PIB) was subsequently developed in 2016 to house the results of the FORCE Evaluation proper, as well as the waist circumference data, in accordance with all regulations. Legal counsel from DND/CF LA saw no à priori issues with the collection of this data, as tracking general physical fitness could easily be justified in terms of overall operational effectiveness of the CAF, and up until this time COs could access individual PES data.

4.2 Guidance to Leaders on the use of their members results

Currently aggregate data are provided at the L3/L4 [Brigade commander/formation (such as fleet Atlantic) and their sub-units (L4: ship specific)]. DND may allow access to subordinates overall incentive level (did the member reach bronze and up) but the CoC will not have access to force times, scores, WC, this data remains personal confidential and cannot be solicited from the subordinate. Guidance to COs explained explicitly that as long as the individual passes the FORCE Evaluation, no punitive action should be taken based on their FP results. The FP is to be used for counselling and goal setting and not to justify sanctions or career actions. In addition, selection of personnel for deployment, operations, training, exercises or any other

purpose should only be based on whether they pass the FORCE Evaluation and not on any other aspect of the FP. The link between health-related fitness or incentive status and the requirements of operations has not been established.

Though the minimal standard on the FORCE Evaluation has been shown to be attainable with training for all ages, and genders, not everyone has the genetic or physiological potential to attain the upper levels of the incentive program. For this reason, it was explained to the COs that is important not to place unrealistic expectations on members of units.

4.2.1 Information Provided to COs

The "colour" attributed to an individual's performance provides the CO with information about his/her unit/members on where improvements can be made in both Operational and Health-related Fitness, helping to direct the CO to the appropriate programs and services through PSP and Health Promotion. Average times for each of the 4 FORCE components are available to a CO at the unit level. If there are weakness in areas such as the aerobic or strength components specifically, these may be a reflection of current physical training (PT) practices and can indicate how to improve and direct future PT in order to improve performance, and produce a more balanced fitness profile. A visual algorithm flow chart was developed to help COs make educated and effective decisions for their subordinates based on FP results (Figure 6).

4.2.2 Not Provided to COs

Individual score as a time or "raw score" is always translated to its relative/percentile score for the Fitness Profile. To compare raw score between individuals does not provide additional information and has the potential to be misinterpreted. It is not possible to extract WC or CRF information from any "color" alone. Therefore, individuals' CRF and WC will remain protected as they are not "operational" measures and the prediction equation/algorithm will not be shared with COs. WC is assessed to be neither an identifier nor a quasi-identifier given the limited range and the ability to visually detect WC. This data will still not be shared with COs as it presents a high risk for misinterpretation with little overall benefit.

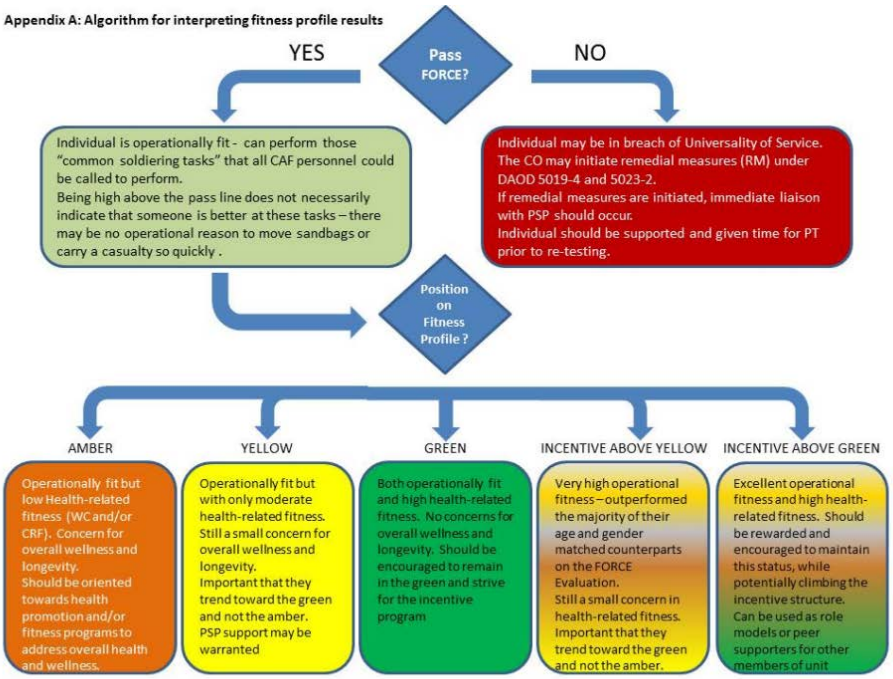

Figure 6. Diagram to demonstrate how the CO can interpret the "colour" on the FP.

4.3 Enhancing the Periodic Health Assessment (PHA)

Through consultations with the committee representing the Surgeon General, it was agreed that cardio-respiratory fitness would enhance the overall risk assessment within the PHA. As indicated, many reports have recommended that CRF assessment should be included in the clinical setting based on the importance of CRF to morbidity and mortality prevention (Cheng et al., 2003; Gulati et al., 2005; Kodama e al., 2009; Myers et al., 2004). The Framingham risk score (currently used as part of the PHA) is a gender specific predictive algorithm that was developed using categorical variables to allow physicians to predict multivariate Coronary heart disease (CHD) risk in patients without overt CHD (Wilson et al., 1998) for up to a 10 year span. The outcome of a fitness profile was not meant to replace or "compete" with the Framingham health risk score – these estimates are assessing distinct constructs. As previously discussed, the protective effect of CRF on mortality is independent of many of the measures considered in the Framingham risk score, such as age, ethnicity, adiposity, smoking status, alcohol consumption as well as health conditions (Blair et al., 2001). It has been recommended to include CRF into the Framingham score as a major risk factor (Kodama et al., 2009), as CRF is also a useful health indicator for both symptomatic and asymptomatic patients in clinical practice (Gibbons et al., 2002; Gulati, et al., 2005; Myers et al., 2002).

Many studies suggest that the assessment of an overweight patient's fitness status is just as important as the measurement of glucose level, cholesterol, blood pressure, smoking and family history (Fogelholm, 2010). While one measure does not replace the other, fitness assessments can complement the health evaluation of an individual especially where one may be categorized as obese but have the shielding effect of a high level of CRF (Blair et al., 2001; Blair et al., 1995; Blair et al., 1996). Blair et al. (1995) observed a decrease in mortality risk in the population (n=10 000 males) who maintained or improved physical fitness present in both healthy and unhealthy men. Results are consistent across age groups, independent of other confounding risk factors. Clinicians should act on this info (CRF) to promote regular physical activity in order to reduce premature deaths from CVD and all causes (Lee et al., 2010).

4.4 How is feedback/evidence being used to measure effectiveness

As indicated, the FORMeFIT system provides timely metrics at L0, L1, L2, and L3, resulting in CoC accountability along the way. Below in Figure 7, an example report where aggregate data is presented to allow for comparisons between Commands.

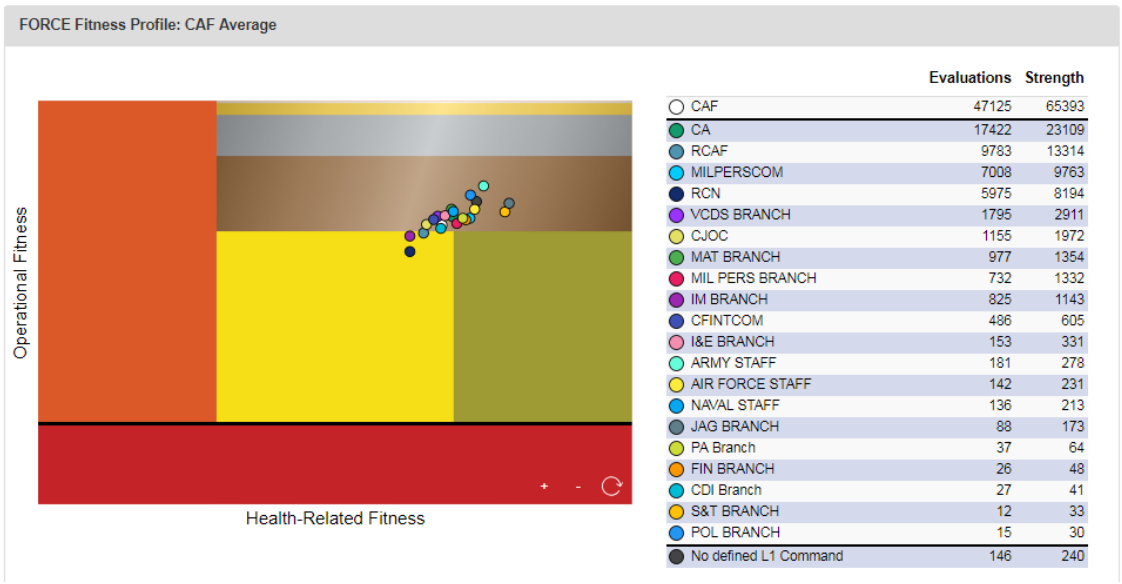

Figure 7. Fitness Profile for L0 (CAF) and L1 (Commands) for Fiscal year 17/18,

The future aim is to provide reporting of all CAF on FORMeFIT, and to include the primary reserve. Currently efforts are directed at learning more about CAF members who are not included in the reporting. These groups are primarily those on temporary medical categories, Mat/Pat leave, still completing paper evaluations, and no-shows or test avoiders. Once the number of test avoiders and their location(s) are identified, more can be done to ensure maximum participation in what is a requirement of employment for all CAF members (DAOD 5023-2).

This year (2019) our organization launched a new Health and Fitness Strategy (BALANCE) and the success of various health promotion and fitness interventions will be evaluated with the metrics received through the FORMeFIT system and the FP. The previous Health and Physical Fitness Strategy (2008) did place a certain responsibility on COs for the fitness of their personnel, but did not provide metrics or a performance measurement tool with which to identify the success or failure of various interventions and resources.

The ability of the monetary reward to incentivise members to improve their FP score will be reviewed on an annual basis, and will evolve as needed. Currently this reward was chosen based upon the results of approximately 15,000 questionnaires and seven focus groups which sought to uncover what CAF personnel would find motivating and attainable in a fitness rewards program (Spivock, 2015).

5.0 FUTURE DIRECTION

5.1 Musculoskeletal Injuries (MSKI)

Cardiorespiratory fitness and WC have been linked to risk of a MSKI in industrial and military populations (Hauret et al, 2018, Jones et al, 2017, Lisman et al, 2017, Lisman et al 2013, Witchalls et al 2017, Zambraski et al, 2012). Poplin et al. (2014) compared levels of aerobic fitness in injured employees with those of non-injured employees. Participants in the lowest fitness level category with a $\dot{V}O_{2max}$ between 43 and 48 ml /kg/min were 1.38 times (95% CI: 1.06 -1.78) more likely to incur injury than those with a $\dot{V}O_{2max}$ above 48 ml/kg/min. Hazard ratios were found to be greater for sprains and strains. They suggest that improving relative aerobic capacity by 1 metabolic equivalent of task (approximately 3.5 ml O_2/kg/min in $\dot{V}O_{2max}$) reduces the risk of any injury by 14%.

Since the implementation of the FORCE Evaluation in 2013, demographics, health-related characteristics, and MSKI sustained during Basic Military Qualification (BMQ) in recruits were investigated. A retrospective analysis of injuries in recruits introduced in the training rehabilitation program during 2016/2017 identified there was a significant relationship between poor performance on FORCE and an increased injury risk, regardless of age and gender. For a population of 7192 over this period, the overall injury rate observed was 4.3% (307 recruits: 183 males, 124 females) (Chassé et al, 2019, under review). Results demonstrated that injured recruits were older, performed worse on FORCE, had a larger WC and lower predicted $\dot{V}O_{2max}$ than non-injured recruits (P<0.01). Three of the four components of FORCE were significant predictors of injuries: 20mR, ILS and SBD with an odds ratio (CI) of 2.69 (1.89-3.83), 2.74 (1.91-3.95), 2.26 (1.52-3.37) (all p<0.01) respectively. Predicted $\dot{V}O_{2max}$ was also a predictor (OR: 2.19 (1.30-3.70) of overuse injury only. It was determined that the CAF PES FORCE is a useful tool to evaluate the risk for injuries during BMQ for the CAF.

Currently the FP does not include a prediction of MSKI, however this recent work exposes the potential to use the Fitness Profile in predicting MSKI and adding a further dimension of Health Related Fitness.

5.2 Feedback on the usefulness of the Fitness Profile and FORMeFit reporting

In January 2019, the Directorate of Fitness polled 37 Fitness and Sports Managers of Bases and Wings across the nation for their feedback regarding the effectiveness of the FORMeFit Reporting system (Chenard, 2019).
Specific questions were posed such as:

1. How often have FSMs utilized FORMeFit Reporting with their Chain of Command (CoC);
2. The feedback of FORMeFit Reporting from the field;
3. The advantages/disadvantages of FORMeFit Reporting;
4. The effectiveness of FORMeFit Reporting on local programs; and
5. The administrative efficiency of FORMeFit Reporting.

The results from the FORMeFit Quarterly Reports Survey confirm that the field is in fact utilizing the FP results as 96% of Fitness and Sports Mangers have accessed and briefed the CoC at their respective location at least once; 25% of which have met and briefed the CoC 3 times or more. The survey identified a strong, consistent interest in further subcategorizing the levels of the CAF.

6.0 SUMMARY

In summary, determining where a CAF member is plotted on the Fitness Profile proves useful to the CAF in several ways:

- CAF personnel have a better understanding of their own fitness level, and will be empowered to take

actions to address issues where they may exist. They are now provided with a metric on their aerobic fitness and their body compositions, components of fitness that were missing in their PES result.

- FORCE Evaluators have a better basis from which to direct CAF personnel to resources to assist in increasing their fitness (e.g., Health Promotion, fitness classes, DFIT.ca, etc.).
- Results are automatically transmitted to the Human Resource Management System (DND/GUARDIAN) which removes the need for paper filing, providing PSP fitness staff the ability to put more focus into programming.
- The CoC are provided a reporting forum for the Operational and Health related fitness of their subordinates, as well as direction how best to use the information
- The 2019 Health and Fitness Strategy BALANCE can be evaluated for longitudinal effectiveness with a sensitive metric.
- In addition, Medical officers can ask a CAF member at their periodic health assessment if they can access the members FP (providing additional information on which to develop a health risk profile)
- The relationship between MSKI and the FP identifies another dimension of risk prediction and therefore has the potential to further enhance the Health related physical fitness component of the Fitness Profile.

7.0 REFERENCES

[1] Born, J., Bogaert, L., Payne, E., & Wiens, M. (2010). Department of National Defence. (2010). 2008/2009 Health and lifestyle information survey: Regular Forces report. http://publications.gc.ca/collections/collection_2011/dn-nd/D2-293-2010-eng.pdf

[2] Casperson, C.J., Powell, K.E., Christenson, G.M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. Mar-Apr; 100(2): 126–131.

[3] Reilly, T. (2014). Aerobic Demands of the FORCE Evaluation. Ottawa, Ontario: Canadian Forces Morale and Welfare Services, Internal Program Evaluation. Unpublished document the Canadian Armed Forces Directorate of Fitness.

[4] Kodama, S, Saito, K, Tanaka, S, Maki, M, Yachi, Y, Asumi, M, Sugawara, A, Totsucka, K, Shimano, H, Ohashi, Y, Yamanda, N, and Sone, H. (2009). Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: A meta-analysis. JAMA 301: 2024–2035.

[5] Laframboise JL, Walsh ES and B Stockbrugger. (2018). Establishing the relationship between cardiorespiratory fitness, and performance on the FORCE evaluation, age, sex and anthropometrics Technical Report: Department of National Defence, Assistant Deputy Minister (Science and Technology). Ottawa.

[6] Grant J, Joseph A and P Campagna. (1999). The prediction of VO2max: A comparison of 7 Indirect Tests of Aerobic Power. J Strength Cond Res. 13(4): 346-352.

[7] George, JD, Paul, S., Hyde A, Bradshaw DI, Vehrs PR, Hager RL, and FG Yanowitz. (2009).

Prediction of Maximum Oxygen Uptake Using Both Exercise and Non-Exercise Data. Measurement in Physical Education and Exercise Science, 13(1): 1-12.

[8] McNaughton L1, Hall P, Cooley D. (1998). Validation of several methods of estimating maximal oxygen uptake in young men. Percept Mot Skills. 1998 Oct;87(2):575- Percept Mot Skills. 87(2):575-84.Zwiren 1991

[9] Jorgensen T, Andersen LB, Froberg K, Maeder U , von Huth Smith L and M Aadahl. (2009). Position statement: Testing physical condition in a population – how good are the methods? Eur J Sp Sc, 9(5): 257-267.

[10] Grant S, Corbett K, Amjad AM, Wilson J, and T Aitchison. (1995). A comparison of predicting maximum oxygen uptake. Br. J Sports Med. 29(3): 147-152.

[11] Penry JT, Wilcox AR, and J Yun. (2011). Validity and Reliability Analysis of Cooper's 12-minute Run and the Multistage Shuttle Run in Healthy Adults. J Strength Cond Res. 25(3):597-605

[12] Leger, LA., and J Lambert (1982). A maximal multistage 20m shuttle run test to predict VO2max. Eur J Appl Physiol. 49(1):1-12. 31.

[13] Leger, L., Mercier, D., Gadoury, C., and J Lambert (1988). The multistage 20 metre shuttle run test for aerobic fitness. Journal of Sports Sciences. 6: 93-101. 32.

[14] Leger, L., and Gadoury, C. (1989). Validity of the 20 meter shuttle run test for aerobic fitness. Canadian Journal of Sports Sciences, 14:21-26.R

[15] Ramsbottom R, Brewer J, and C Williams (1988). A progressive shuttle run test to estimate maximal oxygen uptake. Br J Sports Med. 22(4): 141-4.

[16] McArdle, W.D., Katch, F.I. and V.I. Katch (1991). Exercise Physiology: Energy, Nutrition and Human Performance (3rd ed.) Philidelphia: Lea & Febiger.

[17] Talbot, L; Weinstein, A.; Fleg, J. (2009). Army physical fitness scores predict coronary heart disease in army National Guard soldiers. Military Medicine, 174; 3-245.

[18] Baumgartner, N., Gruse, M. F., & Wilson, W. F. (2018). Morphological Characteristics Associated with Successful and Non-successful Performance on Occupationally Specific, Operationally Relevant Physical Tasks: 2967 Board# 250 June 1 3. Medicine & Science in Sports & Exercise, 50(5S), 736.

[19] Reilly, R., Tipton, M. (2005). Task-based standards for lifeboat crew: Avoiding Ageism. International Congress Series, Assessment and Promotion of Work Ability, Health and Well- being of aging workers. 1280: 219-223.

[20] Poplin, G.S., Roe, D.J., Peate, W., Harris, R.B., Brugess J.L. (2014). The Association of Aerobic Fitness With Injuries in the Fire Service. *Am. J. Epidemiol*. 179 (2):149-155.

[21] Fogelholm, M. (2010). Physical activity, fitness and fatness: Relations to mortality, morbidity and disease risk factors. A systematic review. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *11*(3), 202-221.

[22] Blair, S. N., Cheng, Y., & Holder, J. S. (2001). Is physical activity or physical fitness more important in defining health benefits? *Medicine and Science in Sports and Exercise*, *33*(6 Suppl), S379-99; discussion S419-20.

[23] Blair, S. N., & Jackson, A. S. (2001). Physical fitness and activity as separate heart disease risk factors: A meta-analysis. *Medicine and Science in Sports and Exercise*, *33*(5), 762-764.

[24] Sobolski, J., Kornitzer, M., De Backer, G., Dramaix, M., Abramowicz, M., Degre, S., & Denolin, H. (1987). Protection against ischemic heart disease in the belgian physical fitness study: Physical fitness rather than physical activity? *American Journal of Epidemiology*, *125*(4), 601-610.

[25] Ricciardi, R., Metter, E., Cavanaugh, E., Ghambaryan, A., Talbot, L. (2009). Predicting Cardiovascular risk using measures of regional and total body fat. Applied Nursing Research, 22; 2-9.

[26] Katzmarzyk, P; Craig, C; Gauvin, L. (2007). Adiposity , physical fitness and incident diabetes: the physical activity longitudinal study. Diabetologia, 50:538-544.

[27] Lee, s., Blair, S., Kuk, J., Church, T., Katzmarzyk, P., Ross, R. (2005) .Cardio respiratory fitness attenuates metabolic risk independent of abdominal subcutaneous and visceral fat in men. Diabetes Care 28(4): 895

[28] Lee, D. C., Sui, X., & Blair, S. N. (2009). Does physical activity ameliorate the health hazards of obesity? *British Journal of Sports Medicine*, *43*(1), 49-51.

[29] Lee, D. C., Artero, E. G., Sui, X., & Blair, S. N. (2010). Mortality trends in the general population: The importance of cardiorespiratory fitness. Journal of Psychopharmacology 24(4 Suppl), 27-35.

[30] NHLB, 2013; https://www.nhlbi.nih.gov/health-topics/managing-overweight-obesity-in-adults

[31] WHO 2011. http://www.who.int/mediacentre/factsheets/fs317/en/

[32) Lau, D. C., Douketis, J. D., Morrison, K. M., Hramiak, I. M., Sharma, A. M., & Ur, E. (2007). 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *Cmaj*, *176*(8), S1-S13.

[33] Stevens J, Cai J, Evenson KR, Thomas R. (2002) Fitness and fatness as predictors of mortality from all causes and from cardiovascular disease in men and women in the lipid research clinics study. Am J Epidemiol 156: 832–841 [PubMed]

[34] Stevens J, Evenson KR, Thomas O, Cai J, Thomas R. (2004) Associations of fitness and fatness with

mortality in Russian and American men in the lipids research clinics study. Int J Obes Relat Metab Disord 28: 1463–1470 [PubMed]

[35] Blair, S. N., Kampert, J. B., Kohl, H. W., Barlow, C. E., Macera, C. A., Paffenbarger, R. S., & Gibbons, L. W. (1996). Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *Jama*, *276*(3), 205-210.

[36] Gulati, M., Arnsdorf, M. F., Shaw, L. J., Pandey, D. K., Thisted, R. A., Lauderdale, D. S., ... & Black, H. R. (2005). Prognostic value of the duke treadmill score in asymptomatic women. *The American journal of cardiology*, *96*(3), 369-375.

[37] Myers, J., Kaykha, A., George, S., Abella, J., Zaheer, N., Lear, S., Froelicher, V. (2004). Fitness versus physical activity patterns in predicting mortality in men. *The American Journal of Medicine, 117*(12), 912-918. doi:10.1016/j.amjmed.2004.06.047

[38] Wilson, P. W., D'Agostino, R. B., Levy, D., Belanger, A. M., Silbershatz, H., & Kannel, W. B. (1998). Prediction of coronary heart disease using risk factor categories. Circulation, 97(18), 1837-1847.

[39] Blair, S. N., Kohl, H. W.,3rd, Barlow, C. E., & Gibbons, L. W. (1991). Physical fitness and all-cause mortality in hypertensive men. *Annals of Medicine, 23*(3), 307-312.

[40] Gibbons, L. W., Earnest, C. P., & Church, T. S. (2002). Heart Rate Recovery After Maximal Exercise And Fitness Level Influences Cardiovascular Disease (cvd) And All-cause Mortality Risk In Diabetic Men. *Medicine & Science in Sports & Exercise*, *34*(5), S270.

[41] Blair, S. N., Kohl, H. W., & Barlow, C. E. (1993). Physical activity, physical fitness, and all-cause mortality in women: Do women need to be active? *Journal of the American College of Nutrition*, *12*(4), 368-371.

[42] Myers, J., Prakash, M., Froelicher, V., Do, D., Partington, S., & Atwood, J. E. (2002). Exercise capacity and mortality among men referred for exercise testing. *New England journal of medicine*, *346*(11), 793-801.

[43] Blair, S. N., Kohl, H. W., Barlow, C. E., Paffenbarger, R. S., Gibbons, L. W., & Macera, C. A. (1995). Changes in physical fitness and all-cause mortality: a prospective study of healthy and unhealthy men. *Jama*, *273*(14), 1093-1098.

[44] Blair, S. N., Kampert, J. B., Kohl, H. W.,3rd, Barlow, C. E., Macera, C. A., Paffenbarger, R. S.,Jr, & Gibbons, L. W. (1996). Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *JAMA : The Journal of the American Medical Association*, *276*(3), 205-210.

[45] Spivock, M. Elements of clarification on the Canadian Armed Forces' proposed FORCE Incentive Program: A response to Major Draho's "An Alternate View of Incentivized Fitness in the Canadian Armed Forces,"(CMJ Vol. 15, No. 3, Summer 2015).

[46] Hauret, K. G., Canham-Chervak, M., Schuh-Renner, A., Taylor, B. J., Pierce, J. R., Jones, B. H., & Dada, E. O. (2018). *Injury Surveillance and Longitudinal Studies for Gender Integration in the Army, Second Annual Assessment, 2017* (No. PHR-S. 0047783-17). US Army Public Health Center Aberdeen Proving Ground United States.

[47] Jones, B. H., Hauret, K. G., Dye, S. K., Hauschild, V. D., Rossi, S. P., Richardson, M. D., & Friedl, K. E. (2017). Impact of physical fitness and body composition on injury risk among active young adults: A study of Army trainees. *Journal of science and medicine in sport*, *20*, S17-S22.

[48] Lisman, P. J., Sarah, J., Gribbin, T. C., Jaffin, D. P., Murphy, K., & Deuster, P. A. (2017). A Systematic Review of the Association Between Physical Fitness and Musculoskeletal Injury Risk: Part 1—Cardiorespiratory Endurance. *The Journal of Strength & Conditioning Research*, *31*(6), 1744-1757.

[50] Witchalls, J., McDonald, C., Richardson, A., & Newman, P. (2017). Injury risk in specific body regions is associated with performance in the Army basic fitness assessment in Army staff cadets. *Journal of Science and Medicine in Sport*, *20*, S27.

[51] Zambraski, E. J., & Yancosek, K. E. (2012). Prevention and rehabilitation of musculoskeletal injuries during military operations and training. *The Journal of Strength & Conditioning Research*, *26*, S101-S106.

[52] Étienne Chassé[1]Marie-Andrée Laroche[2], Guillaume Leclerc[1 2], Carole-Anne Dufour[3], Renaud A. Guimond[3], François Lalonde[1,4,5] JSCP in review Association between Musculoskeletal Injuries and the Canadian Armed Forces Physical Employment Standard in Canadian Military Recruits.

[53] Chenard, K, January 2019. FORMeFIT Quarterly Reporting , Survey and Analysis.