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Financial Impact of Embedded Injury-Prevention Experts in US Army Initial Entry Training

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Context: The US Army embedded injury-prevention experts (IPEs), specifically athletic trainers and strength and conditioning coaches, into initial entry training (IET) to limit musculoskeletal (MSK) conditions and their negative consequences. However, little is known about the financial impact of IPEs.

Objective: To assess whether IPEs were associated with fewer sunk training costs due to MSK-related early discharges from service.

Design: Retrospective cohort study.

Setting: Database of US Army soldiers' administrative, medical, and readiness records.

Patients or Other Participants: A total of 198 166 soldiers (age = 20.7 ± 3.2 years, body mass index = 24.4 ± 3.5 kg/m^2) who began IET during 2014 to 2017.

Main Outcome Measure(s): *Early discharge from service* was defined as occurring within 6 months of beginning IET. All IET sites employed IPEs from 2011 to 2017, except for 2 sites during April to November 2015. Soldiers who began IET at these 2 sites during these times were categorized as not having IPE exposure. All others were categorized as having IPE exposure. The unadjusted association between IPE access and MSK-related early discharge from service was assessed using logistic regression. Financial impact was assessed by quantifying differences in yearly sunk costs between groups with and those without IPE exposure and subtracting IPE hiring costs.

Results: Among 14 094 soldiers without IPE exposure, 2.77% were discharged early for MSK-related reasons. Among 184 072 soldiers with IPE exposure, 1.01% were discharged. Exposure to IPEs was associated with reduced odds of MSK-related early discharge (odds ratio = 0.36, 95% CI = 0.32, 0.40, $P < .001$) and a decrease in yearly sunk training costs of $11.19 to $20.00 million.

Conclusions: Employing IPEs was associated with reduced sunk costs because of fewer soldiers being discharged from service early for MSK-related reasons. Evidence-based recommendations should be developed for guiding policy on the roles and responsibilities of IPEs in the military to reduce negative outcomes from MSK conditions and generate a positive return on investment.

Key Words: return on investment, service discharge, military, musculoskeletal injuries

Key Points

- Exposure to injury-prevention experts during US Army initial entry training was associated with a reduced likelihood of early discharge from service for musculoskeletal condition-related reasons.
- The reduced likelihood of early discharge from service for musculoskeletal condition-related reasons resulted in an estimated decrease in yearly sunk training costs of $11.19 million to $20 million.

Improving the prevention and treatment of musculoskeletal (MSK) conditions is a top priority of the US military because of the short- and long-term impacts MSK conditions have on medical readiness. This is especially true for the US Army, in which MSK conditions account for 2 million medical encounters[1,2] and 8 million limited-duty days among soldiers[3] each year. Negative impacts of MSK conditions often occur early in a soldier's career and account for >50% of disability-related discharges within the first year of service.[4] Additionally, approximately 25% of men and 50% of women experience MSK conditions during US Army initial entry training (IET),[2,5] increasing their likelihood of early discharge from service. Approximately 25% of men and women with MSK conditions during IET are discharged before completing training.[2]

In an attempt to prevent MSK conditions during IET and their negative consequences (eg, lost training or duty days, early-career discharge from service), the US Army began embedding injury-prevention experts (IPEs), specifically certified athletic trainers (ATs) and strength and conditioning specialists, into IET starting in 2010.[6] Athletic trainers have the potential to prevent severe MSK conditions and their negative outcomes through early recognition and

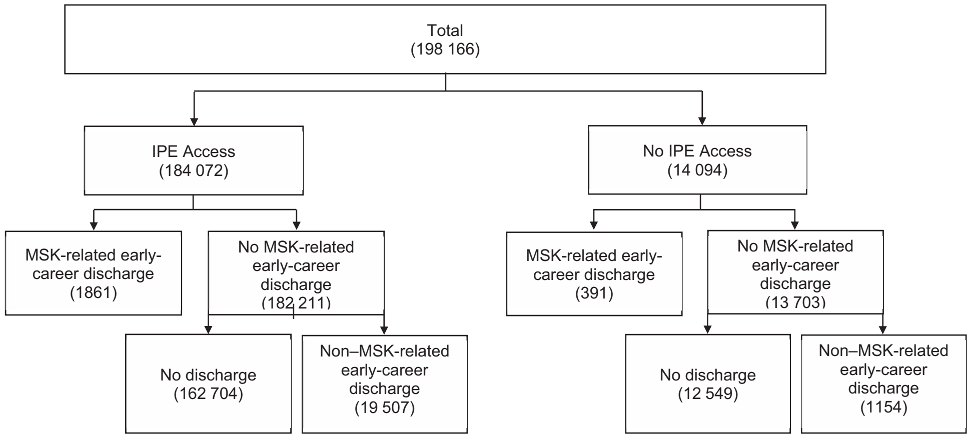

Figure. Breakdown of soldiers by injury-prevention expert (IPE) access during US Army initial entry training and early-career discharge status (ie, musculoskeletal [MSK]-related, non–MSK-related, no discharge).

treatment,[6–10] whereas strength and conditioning specialists have the potential to prevent MSK conditions through improved physical conditioning of recruits.[6,11–13] Further, ATs and strength and conditioning specialists are equipped to address common, modifiable risk factors for MSK conditions in physically active populations, such as high or low body mass index[14–17] and poor movement quality,[18] balance,[19,20] and physical conditioning.[6,11–13,21]

Although more than a decade has elapsed since IPEs were first embedded in IET, little is known about the beneficial impact they have had on the US Army. A report published in 2011 by an Army Public Health Center research team compared the benefits of musculoskeletal action teams (MATs; ATs, strength and conditioning specialists, physical therapists, and physical therapy technicians) and physical therapists alone at the same IET site.[6] The MATs were as effective in preventing MSK conditions as physical therapists alone, but the analysis was limited to 1 IET site over 1 year. Additionally, the researchers primarily evaluated the impact on the incidence of MSK conditions and medical attrition during training.[6] However, IPEs may show further value when evaluated on metrics such as cost. As a result, the impact of IPEs across multiple IET sites for multiple years and benefits beyond reducing the incidence of MSK conditions and medical attrition during training need to be assessed.

Given the costs associated with employing IPEs, quantifying their financial impact and potentially positive return on investment may be beneficial to the US Army. This may aid the Army in justifying the continued employment of IPEs in IET, as well as expansion of the IPE presence beyond IET. One area in which IPEs may generate a positive financial return on investment is in reducing MSK-related early-career discharges from service, either by preventing initial MSK conditions or preventing MSK conditions from progressing to the point at which a soldier can no longer continue in service. Decreasing MSK-related early-career discharges would then result in fewer training dollars spent on soldiers who ultimately are discharged from service early (ie, a reduction in sunk training costs).

Therefore, we aimed to evaluate whether (1) embedding IPEs in IET was associated with fewer early service discharges for MSK-related reasons and (2) changes in early service discharges for MSK-related reasons resulted in fewer *sunk training costs* (ie, training dollars spent in a given year on soldiers who were subsequently discharged from service early), generating a positive financial return on investment.

METHODS

Data Set and Study Population

We performed a retrospective cohort study using the Medical Assessment and Readiness System database housed at Womack Army Medical Center, Fort Liberty, North Carolina. We merged monthly administrative, medical, and readiness data on 198 166 active-duty soldiers (age = 20.7 ± 3.2 years, body mass index = 24.4 ± 3.5 kg/m^2) who began IET between January 2014 and May 2017. Only active-duty soldiers who began IET before May 2017 were included in the analyses to ensure that enough time remained in which to observe early discharges from service. The Figure depicts a breakdown of soldiers by IPE access during IET and early-career discharge status (ie, MSK-related, non–MSK-related, no discharge). Study procedures were reviewed and approved by the Womack Army Medical Center Human Research Protection Office.

Access to IPEs

According to information provided by the Physical Performance Service Line of the US Army Office of the Surgeon General, all of the Army's IET sites (Fort Sill, Fort Benning, Fort Jackson, and Fort Leonard Wood) had employed IPEs since 2011. However, Fort Sill and Fort Leonard Wood did not have IPEs from April 2015 through November 2015 because of a lapse in contracts. Thus, soldiers who began IET at either Fort Sill or Fort Leonard Wood from April 2015 through November 2015 were categorized as not having exposure to IPEs. All others were categorized as having exposure to IPEs.

Cost Estimation

Cost of IPEs. The estimated yearly cost of contracting IPEs was provided by the Physical Performance Service Line of the US Army Office of the Surgeon General. Contracting costs were based on the cost of hiring 5 ATs and 6 certified strength and conditioning specialists at each of the Army's IET sites (Fort Sill, Fort Benning, Fort Jackson, and Fort Leonard Wood). The yearly cost of the program during the time of our data was estimated to be $3.56 million ($891 000 per IET site).

Army Recruit Training Cost. The estimated average cost of training 1 recruit was provided by the Center for Initial Military Training (CIMT), located within the US Army Training and Doctrine Command. The estimated cost was supplied for each component of IET (ie, basic combat training [BCT] and advanced individual training [AIT]) as well as for recruits attending one-station unit training (OSUT), in which BCT and AIT occur at the same site. The BCT is a 10-week (70-day) entry-level training course in which recruits are educated on the basic principles of being a soldier, and AIT is a secondary training course in which recruits are instructed in tasks specific to their career field.[22] The AIT varies in length by career field and over time as changes are made to Army training. Furthermore, the length of time between when a recruit completes BCT and enters AIT depends on whether additional training is needed before the recruit enters AIT, such as learning a foreign language.

Because of variations in AIT length among career fields and over time, as well as in variations in the lengths of time between completing BCT and entering AIT, identifying the exact amount of time each service member spent in AIT was not feasible. However, information provided by the CIMT indicated that the majority of soldiers completed IET within 6 months, and because the first 10 weeks of IET consist of BCT, we estimated that the remainder of the 6 months was spent in, or shortly after, AIT. Therefore, for the purpose of this study, AIT was estimated at 16 weeks (112 days) long. When it is preceded by BCT, the total length of training equals approximately 6 months (26 weeks or 182 days). For this study, we considered OSUT approximately 6 months long (26 weeks or 182 days). Because training costs can change over time, recruit training costs for BCT, AIT, and OSUT were provided by the CIMT for each of the 2014 to 2017 fiscal years.

Early-Career Discharge From Service

Discharges from active-duty service that constituted outcomes for the analysis were those that met 2 criteria: (1) they occurred early or before completion of the expected tour of duty after IET and (2) they were associated with MSK conditions. Discharges meeting the first criterion were those that occurred within 6 months after entering service. We chose this time frame because it constitutes a period in which, based on information provided by the CIMT, most soldiers either were in the later phases of IET or were newly graduated from it and, hence, may have had recent access to IPEs.

Participants meeting the second criterion (ie, early discharge associated with MSK conditions) demonstrated $\geq$1 clinical encounters or hospital admissions involving selected MSK conditions by the time of discharge. Conditions were identified by using International Classification of Diseases[23] diagnosis codes taken from electronic records of outpatient and inpatient health care. New soldiers undergo initial screening upon entry to service to identify major and chronic MSK conditions that are generally disqualifying (Army Regulation 40-501).[24] We therefore selected MSK conditions that were likely to occur among soldiers in their early careers and might be affected by IPE exposure. The selected conditions included injuries and pain syndromes that might arise anew or be revealed under the stress of military training; traumatic brain injuries were not considered MSK conditions in this study. We did not select MSK conditions that appeared likely to be associated with infectious, autoimmune, or neoplastic origins or that might have a lower probability of being affected by IPEs. The diagnosis codes selected are listed in the Appendix. Soldiers discharged early because of conditions not listed in the Appendix were included in the category of soldiers who were not discharged for MSK-related reasons. These soldiers were included so the analyses reflected all individuals going through training during the time period, without penalizing IPEs for cases they could not realistically affect. Moreover, including these soldiers did not meaningfully change our findings; the odds ratio comparing the odds of MSK-related early-career discharge from service between soldiers with and those without access to IPEs changed by 0.01 points when these individuals were included in the analyses.

Analysis

Early-Career Discharge From Service Analysis. We used binomial logistic regression and odds ratios with 95% CIs to determine whether a statistically significant unadjusted association existed between IPE access and discharge from service within 6 months after service entry. Binomial logistic regression was performed using IPE access as the sole independent variable and the presence of early-career MSK-related discharge as the binary outcome of interest. We created 2×2 contingency tables separately for each of the first 6 months of service to calculate the percentages of soldiers with and those without access to IPEs who were discharged each month. These percentages were then used in the financial impact analysis described in the next paragraph. Statistical significance for the χ^2 analyses was set a priori at $P < .05$.

Financial Impact Analysis. Financial impact was estimated by quantifying differences in yearly sunk costs between soldiers with and those without access to IPEs during their time in IET and subtracting yearly IPE contract costs. *Yearly sunk costs* (ie, training dollars spent in a given year on soldiers who were subsequently discharged from service early) were computed by summing *monthly sunk costs* (ie, training dollars spent in a given month on soldiers who were subsequently discharged from service early). The total amount of money spent on soldiers increases the longer they are in training or service, and therefore, sunk costs should reflect the length of time soldiers spend in training, service, or both. Monthly sunk costs were therefore calculated as the product of (1) the percentage of soldiers discharged in a given month, (2) the number of soldiers in training in that month, (3) the number of training days exposed up to the time of discharge in that month, and (4) the median daily cost of training 1 soldier in that month.

The percentage of soldiers discharged in a given month was based on monthly discharge percentages of the 198 166 soldiers in our data set. The number of soldiers in training in a given month was based on a typical yearly recruiting

Table 1. Median Yearly and Daily Costs to Train 1 Soldier During Training, 2014–2017

Training	Median Cost, $	
	Yearly	Daily
Basic combat	17 500.00	250.00
Advanced individual	29 250.00	261.16
One-station unit	28 900.00	158.79

size of 62 500 individuals and the percentage that we would expect to have been discharged by that given month (based on the monthly discharge rates in our data set). The typical yearly recruiting size of 62 500 individuals was provided to the research study team by the CIMT.

We used a longitudinal data set that was based on the person-month and did not offer visibility on submonth trajectories. Thus, because we could not observe exactly when soldiers began training in their first service month, all participants were treated as having experienced a half month of training time in the first IET month. Additionally, those discharged from service in the first month of IET were treated as having experienced 50% of the possible training time, ie, a quarter month (7.5 days), because of the initial administrative time that precedes actual training. Soldiers were treated as having 30.5 possible training days in each of months 2 to 6 because some months consisted of 30 calendar days and others, 31 calendar days. For months 2 to 6 in which soldiers were discharged, exposure to training days was managed similarly to the first service month; that is, soldiers were treated as having participated in 50% of the possible training days in the last observed month.

Median daily training costs were determined by taking the median cost to train 1 soldier during the 2014 to 2017 time period and spreading that cost over 182 training days (26 weeks or 6 months). For OSUT, this calculation was performed simply by dividing the median yearly cost to train 1 soldier during OSUT from 2014 to 2017 by 182 days. For soldiers attending BCT and AIT individually, this was performed by calculating the cost of training 1 soldier during BCT and AIT separately and then summing those costs. Median daily training costs for BCT were computed by dividing the median yearly cost to train 1 soldier during BCT from 2014 to 2017 over 70 days (7 d/wk over 10 weeks). For soldiers attending AIT, this was performed by dividing the median yearly cost to train 1 soldier during AIT from 2014 to 2017 over 112 days (7 d/wk over 16 weeks). The estimated median yearly and daily costs to train 1 soldier during BCT, AIT, and OSUT are shown in Table 1.

Because training costs vary in terms of the phase and occupation-specific type of training (eg, BCT, AIT, OSUT) and the number of soldiers who attend each training course varies year by year, estimating the financial impact can be challenging. As a result, we calculated financial impact under 2 conditions: (1) by treating all soldiers observed in a given year as having attended OSUT and (2) by treating all soldiers observed in a given year as having attended BCT and AIT separately. This allowed us to estimate the smallest and largest financial impact we might expect in a given year, given that it is less expensive to train soldiers attending OSUT than to train soldiers attending BCT and AIT separately.

RESULTS

Early-Career Discharge from Service

Among the 198 166 soldiers with records used in this study, 7.11% (n = 14 094) did not have exposure to IPEs during IET. Of the 14 094 soldiers without IPE exposure, 2.77% (n = 391) were discharged early for MSK-related reasons. Among the 184 072 soldiers with IPE exposure, 1.01% (n = 1861) were discharged early for MSK-related reasons. Exposure to IPEs was statistically significantly associated with reduced odds of MSK-related early-career discharge (odds ratio = 0.36, 95% CI = 0.32, 0.40, $P < .001$). Monthly percentages of soldiers with and those without access to IPEs who were discharged from service early for MSK-related reasons are supplied in Table 2.

Estimated Financial Impact

Estimated monthly sunk training costs and yearly financial impact under the condition that all soldiers attended OSUT are presented in Table 3. This difference in sunk costs between soldiers who did and those did not have access to IPEs represents the smallest yearly financial impact that might be expected from IPEs in IET. We estimated that IPEs in IET may reduce sunk training costs by at least $11.19 million annually, an amount approximately 3 times greater than the yearly cost of contracting IPEs.

Estimated monthly sunk training costs and yearly financial impact under the condition that all soldiers attended BCT and AIT separately are depicted in Table 4. This difference in sunk costs between soldiers who did and those who did not have access to IPEs represents the largest yearly financial impact that might be expected from IPEs in IET. We estimated that IPEs in IET may reduce sunk training costs by up to $20 million annually, an amount approximately 5.6 times greater than the yearly cost of contracting IPEs.

DISCUSSION

We aimed to evaluate whether embedding IPEs in IET was associated with decreased sunk training costs as a result of fewer soldiers being discharged from service early for MSK-related reasons and whether changes in sunk training costs produced a positive financial return on investment. Our findings indicated that embedding IPEs was associated with a lower likelihood of early-career MSK-related discharges and a reduction of annual sunk costs upward of $20 million.

Table 2. Monthly Discharge Percentages of Soldiers With and Those Without Access to IPEs During Initial Entry Training

Discharge Month	% Discharged		Difference in % Discharged (No IPE Minus IPE)
	IPE Access	No IPE Access	
1	0.1	0.2	0.1
2	0.3	0.8	0.5
3	0.2	0.5	0.3
4	0.2	0.5	0.3
5	0.2	0.5	0.3
6	0.2	0.5	0.3

Abbreviation: IPE, injury-prevention experts.

Table 3. Estimated Yearly Financial Impact if Every Soldier Attended One-Station Unit Training (Minimum Impact Expected), 2014–2017

	IPE Access			No IPE Access		
Discharge Month	Soldiers in Training	% Discharged	Monthly Sunk Cost, $ Millions	Soldiers in Training	% Discharged	Monthly Sunk Cost, $ Millions[a]
1	62 500	0.09	0.07	62 500	0.20	0.15
2	62 443	0.27	0.80	62 376	0.75	2.25
3	62 277	0.23	1.39	61 908	0.52	3.11
4	62 132	0.16	1.45	61 585	0.48	4.29
5	62 032	0.15	1.80	61 289	0.48	5.71
6	61 939	0.18	2.69	60 993	0.50	7.44
Yearly sunk cost[a]			8.20			22.95
Minimum estimated yearly financial impact			11.19			

Abbreviation: IPE, injury-prevention experts.
[a] Costs presented in millions of dollars.

Early-Career Discharge From Service

Our observation that IPEs were associated with a smaller percentage of soldiers discharged early for MSK-related reasons was similar to research performed in US Army BCT and OSUT,[6] as well as in US Air Force basic military training (BMT).[25,26] Medical attrition in Army BCT and OSUT was reduced by up to 50% when recruits had access to MATs.[6] It is important to note that ATs alone did not have a statistically significant impact on medical attrition,[6] potentially highlighting the importance of a team approach to preventing negative outcomes from MSK conditions. The MSK-related attrition risk in Air Force BMT was 25% lower among recruits with access to embedded ATs than among recruits without such access, with an absolute reduction of 0.31%.[25]

The impact of IPEs in Army IET appeared to be larger than in BMT. We identified that the percentage of Army soldiers discharged early for MSK-related reasons was 64% lower among those with access to IPEs during IET, with an absolute reduction of 1.76%. The reason for increased impact in Army IET than in the Air Force may be 2-fold: (1) both ATs and strength and conditioning specialists were embedded in Army IET, which could increase the opportunity for impact and (2) the physically demanding nature of Army training may allow for a greater impact, as evidenced by higher MSK-related discharge rates in IET (2.77%) compared with BMT (1.25%)[25] when neither IPEs nor ATs were present.

Although beyond the scope of our work, further study is warranted to evaluate the extent to which the IPE impact may differ among AIT and OSUT sites, career fields, and the physical demands of training for those career fields and, therefore, the risk of MSK-related early-career discharge from service may also naturally differ among training sites. It is important to note that although the training site may be associated with early-career service discharge, it does not likely confound the general impact of IPEs, because analyses performed outside the purpose of this study indicated that the IPE impact was meaningful when accounting for a host of other factors, including training site (no IPE versus IPE adjusted hazard ratio = 1.34, 95% CI = 1.20, 1.51). Future investigators should also examine the mechanisms through which IPEs appear to be associated with early-career discharges. Athletic trainers may help reduce the stigma surrounding seeking care for MSK conditions,[25,27,28] which results in soldiers seeking care earlier. Early care seeking may prevent MSK conditions from progressing in severity and the subsequent negative consequences such as discharge from service.[6–10] The presence of strength and conditioning specialists could also be associated with early-career discharges by developing and implementing programming to improve the physical fitness of soldiers so they are able to withstand the physical rigors of IET.[11,12,21] Additionally, classes educating soldiers on proper technique for activities such as running[25,29] or foot marching with a rucksack[30,31] may aid in reducing the risk of MSK conditions and their negative consequences,

Table 4. Estimated Yearly Financial Impact if Every Soldier Attended Basic Combat and Advanced Individual Training Separately (Maximum Impact Expected), 2014–2017

	IPE Access			No IPE Access		
Discharge Month	Soldiers in Training	% Discharged	Monthly Sunk Cost, $ Millions	Soldiers in Training	% Discharged	Monthly Sunk Cost, $ Millions[a]
1	62 500	0.09	0.11	62 500	0.20	0.23
2	62 443	0.27	1.26	62 376	0.75	3.54
3	62 277	0.23	2.19	61 908	0.52	4.90
4	62 132	0.16	2.31	61 585	0.48	6.83
5	62 032	0.15	2.89	61 289	0.48	9.16
6	61 939	0.18	4.33	60 993	0.50	11.99
Yearly sunk cost			13.09			36.65
Maximum estimated yearly financial impact			20.00			

Abbreviation: IPE, injury-prevention expert.

such as early-career discharge. These mechanisms can then be used to develop evidence-based recommendations that guide policies on the roles and responsibilities of IPEs to reduce early-career MSK-related discharges.

Estimated Financial Impact

Despite a seemingly small reduction in the percentage of soldiers with access to IPEs who were discharged early, a positive financial return on investment still occurred, likely because of the size of the US Army. With an average annual recruiting size of 62 500 soldiers, reducing attrition by a small percentage can reduce sunk costs by a meaningful margin. Although few authors of peer-reviewed research have assessed the financial impact of IPEs in a military setting, our findings are similar to the results of studies performed at US Air Force BMT.[25,26] Embedding ATs into BMT was associated with $2 to $4 million in cost savings yearly.[25,26] The greater financial impact in Army IET versus Air Force BMT may reflect the physical nature of IET. The physical nature of IET may increase the impact IPEs can have in the US Army compared with other services, as shown by our results on early-career discharges, which in turn may translate to a greater financial impact. Differences between services in gross cost savings may be due to differences in annual recruiting sizes. Large recruiting sizes provide the opportunity for IPEs to affect more recruits than services with smaller recruiting sizes, increasing the total amount of possible cost savings.

Our financial impact outcomes may have significant implications. Because the yearly cost savings (ie, reduced sunk costs) were up to 5.6 times greater than the yearly cost of contracting IPEs, continued funding of IPEs in IET is strongly encouraged. This is especially true because our estimate of financial impact was conservative and did not include further potential cost savings, such as those from reducing the need for surgeries and associated surgical costs; hence, the true financial impact may be even larger. Evaluating the financial impact or return on investment is vital to the sustained success of any program in the US military; hence, it is critical that other programs that embed MSK professionals in training develop a plan to determine their financial impact. Doing so may help ensure that evidence-based recommendations developed to guide policy on the roles and responsibilities of embedded MSK professionals not only reduce negative outcomes from MSK conditions but also generate a positive return on investment.

Limitations

An inherent limitation of our work is that we lacked daily military service records for the soldiers in our data set; we were provided records that reflected personnel information known at the end of each month. We therefore made assumptions about how many training days soldiers were exposed to in a given month, particularly in the first month of training and the month in which a soldier was discharged. We found this limitation acceptable because it was evenly applied to all participants, and it could introduce an approximate maximum of 2 weeks of error per affected month into an estimate for a given soldier.

We were also limited by the many ways in which IPEs may generate a positive financial impact and return on investment beyond what we examined (ie, reducing sunk training costs from early-career discharges). Thus, our financial impact estimates are likely conservative estimates of the true impact of IPEs. For example, they might be greater if we included cost estimates of how reductions in the need for surgeries or visits to specialty medical providers (eg, orthopedists) may alter costs. Otherwise, we were restricted by the use of International Classification of Diseases coding to identify relevant medical conditions, which can introduce misclassification of diagnoses due to provider choices.

Lastly, because of the inherent limitations of the data sets used in this study, we were unable to evaluate specific mechanisms through which IPEs may affect early-career discharges. Variation in how IPEs are used across IET sites, as well as potential periodic gaps in staffing that occur naturally because of IPEs changing jobs, may influence the IPE impact. This inherent limitation provides justification for future researchers to systematically evaluate mechanisms through which IPEs may affect early-career discharges.

CONCLUSIONS

We aimed to establish whether IPEs embedded in IET were associated with fewer sunk training costs as a result of fewer soldiers being discharged from service early for MSK-related reasons and whether changes in sunk training costs resulted in a positive financial return on investment. Our findings suggest that continued funding of IPEs in IET could be advantageous, because they were associated with a lower likelihood of early-career MSK-related discharges and a reduction in yearly sunk training costs by upward of $20 million. This is an amount 5.6 times greater than the yearly cost of contracting IPEs. Future researchers should (1) examine the mechanisms by which IPEs affect US Army early-career discharges and (2) evaluate the financial impact of other US military programs that embed MSK professionals in training settings. Results from such studies can aid in the development of evidence-based recommendations that guide policy on the roles and responsibilities of embedded MSK professionals to not only reduce negative outcomes from MSK conditions but also generate a positive return on investment.

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REFERENCES

1. Jones BH, Hauschild VD. Physical training, fitness, and injuries: lessons learned from military studies. *J Strength Cond Res*. 2015;29 (suppl 11):S57–S64. doi:10.1519/JSC.0000000000001115
2. Knapik JJ, Canham-Chervak M, Hauret K, Hoedebecke E, Laurin MJ, Cuthie J. Discharges during US Army basic training: injury rates and risk factors. *Mil Med*. 2001;166(7):641–647.
3. Molloy JM, Pendergrass TL, Lee IE, Chervak MC, Hauret KG, Rhon DI. Musculoskeletal injuries and United States Army readiness

part I: overview of injuries and their strategic impact. *Mil Med*. 2020;185(9–10):e1461–e1471. doi:10.1093/milmed/usaa027
4. *2019 Annual Report:* Accession medical standards analysis and research activity. Walter Reed Army Institute of Research. Accessed March 24, 2023. wrair.health.mil/Portals/87/DESAR_Annual_Report_FY2019_Final_.pdf
5. Hauschild VD, Lee T, Barnes S, Forrest L, Hauret K, Jones BH. The etiology of injuries in US Army initial entry training. *US Army Med Dep J*. 2018;(2–18):22–29.
6. Knapik J, Graham B, Cobbs J, et al. *The Soldier-Athlete Initiative: Program Evaluation of the Effectiveness of Athletic Trainers Compared to Musculoskeletal Action Teams in Initial Entry Training, Fort Leonard Wood, June 2010–December 2011*. US Army Institute of Public Health; 2012. Report No. S.0007856-11.
7. Shanley E, Thigpen CA, Chapman CG, Thorpe J, Gilliland RG, Sease WF. Athletic trainers' effect on population health: improving access to and quality of care. *J Athl Train*. 2019;54(2):124–132. doi:10.4085/1062-6050-219-17
8. Fritz JM, Childs JD, Wainner RS, Flynn TW. Primary care referral of patients with low back pain to physical therapy: impact on future health care utilization and costs. *Spine (Phila Pa 1976)*. 2012;37(25): 2114–2121. doi:10.1097/BRS.0b013e31825d32f5
9. Gellhorn AC, Chan L, Martin B, Friedly J. Management patterns in acute low back pain: the role of physical therapy. *Spine (Phila Pa 1976)*. 2012;37(9):775–782. doi:10.1097/BRS.0b013e3181d79a09
10. Ojha HA, Snyder RS, Davenport TE. Direct access compared with referred physical therapy episodes of care: a systematic review. *Phys Ther*. 2014;94(1):14–30. doi:10.2522/ptj.20130096
11. Henning PC, Khamoui AV, Brown LE. Preparatory strength and endurance training for U.S. Army basic combat training. *Strength Cond J*. 2011;33(5):48–57. doi:10.1519/SSC.0b013e31822fdb2e
12. Knapik JJ, Rieger W, Palkoska F, Camp SV, Darakjy S. United States Army physical readiness training: rationale and evaluation of the physical training doctrine. *J Strength Cond Res*. 2009;23(4): 1353–1362. doi:10.1519/JSC.0b013e318194df72
13. Chalupa RL, Aberle C, Johnson AE. Observed rates of lower extremity stress fractures after implementation of the Army Physical Readiness Training Program at JBSA Fort Sam Houston. *US Army Med Dep J*. January–March 2016:6–9.
14. Bedno SA, Nelson DA, Kurina LM, Choi YS. Gender differences in the associations of body mass index, physical fitness and tobacco use with lower extremity musculoskeletal injuries among new US Army soldiers. *Inj Prev*. 2019;25(4):295–300. doi:10.1136/injuryprev-2017-042669
15. Anderson MK, Grier T, Canham-Chervak M, Bushman TT, Jones BH. Occupation and other risk factors for injury among enlisted US Army soldiers. *Public Health*. 2015;129(5):531–538. doi:10.1016/j.puhe.2015.02.003
16. Nelson DA, Wolcott VL, Kurina LM. Prediction of all-cause occupational disability among US Army soldiers. *Occup Environ Med*. 2016;73(7):442–451. doi:10.1136/oemed-2015-103436
17. McCarthy MS, Elshaw EB, Szekely BM, Pflugeisen B. Health promotion research in active duty army soldiers: the road to a fit and ready force. *Nurs Outlook*. 2017;65(5S):S6–S16. doi:10.1016/j.outlook.2017.06.009
18. Everard E, Lyons M, Harrison AJ. Examining the association of injury with the Functional Movement Screen and Landing Error Scoring System in military recruits undergoing 16 weeks of introductory fitness training. *J Sci Med Sport*. 2018;21(6):569–573. doi:10.1016/j.jsams.2017.05.013
19. de la Motte SJ, Lisman P, Gribbin TC, Murphy K, Deuster PA. Systematic review of the association between physical fitness and musculoskeletal injury risk: part 3—flexibility, power, speed, balance, and agility. *J Strength Cond Res*. 2019;33(6):1723–1735. doi:10.1519/JSC.0000000000002382
20. Keenan KA, Wohleber MF, Perlsweig KA, et al. Association of prospective lower extremity musculoskeletal injury and musculoskeletal, balance, and physiological characteristics in Special Operations Forces. *J Sci Med Sport*. 2017;20(suppl 4):S34–S39. doi:10.1016/j.jsams.2017.09.002
21. Teyhen DS, Shaffer SW, Butler RJ, et al. What risk factors are associated with musculoskeletal injury in US Army Rangers? A prospective prognostic study. *Clin Orthop Relat Res*. 2015;473 (9):2948–2958. doi:10.1007/s11999-015-4342-6
22. Army regulation 350-6: enlisted initial entry training policies and administration. Training and Doctrine Command, Department of the Army. Published 2019. Accessed March 24, 2023. adminpubs.tradoc.army.mil/regulations/TR350-6.pdf
23. Classification of Diseases, Functioning, and Disability. Centers for Disease Control and Prevention. Updated July 23, 2021. Accessed July 30, 2021. https://www.cdc.gov/nchs/icd/index.htm
24. Army regulation 40-501: standards of medical fitness. Department of the Army. Published 2019. Accessed March 24, 2023. https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN37720-AR_40-501-002-WEB-4.pdf
25. Fisher R, Esparza S, Nye NS, et al. Outcomes of embedded athletic training services within United States Air Force basic military training. *J Athl Train*. 2021;56(2):134–140. doi:10.4085/1062-6050-0498.19
26. Nye NS, Pawlak MT, Webber BJ, Tchandja JN, Milner MR. Description and rate of musculoskeletal injuries in Air Force basic military trainees, 2012–2014. *J Athl Train*. 2016;51(11):858–865. doi:10.4085/1062-6050-51.10.10
27. Cohen BS, Pacheco BM, Foulis SA, et al. Surveyed reasons for not seeking medical care regarding musculoskeletal injury symptoms in US Army trainees. *Mil Med*. 2019;184(5–6):e431–e439. doi:10.1093/milmed/usy414
28. Britt TW, Sipos ML, Klinefelter Z, Adler AB. Determinants of mental and physical health treatment-seeking among military personnel. *Br J Psychiatry*. 2020;217(2):420–426. doi:10.1192/bjp.2019.155
29. Miller EM, Crowell MS, Morris JB, Mason JS, Zifchock R, Goss DL. Gait retraining improves running impact loading and function in previously injured U.S. military cadets: a pilot study. *Mil Med*. 2021;186(11–12):e1077–e1087. doi:10.1093/milmed/usaa383
30. Almonroeder TG, Harding L, Seubert B, Cowley H, Kernozek T. The effects of incremental changes in rucksack load on lower extremity joint kinetic patterns during ruck marching. *Ergonomics*. 2021;64(8):971–982. doi:10.1080/00140139.2021.1893391
31. Fox BD, Judge L, Dickin DC, Wang H. Biomechanics of military load carriage and resulting musculoskeletal injury: a review. *J Orthop Orthop Surg*. 2020;1(1):6–11. doi:10.29245/2767-5130/2020/1.1104

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Appendix. International Classification of Diseases (ICD) Codes Used to Identify Musculoskeletal Conditions[23]

Code or Prefix	ICD Revision	Description
716.1	9	Traumatic arthropathies
717	9	Internal derangement of knee
718	9	Other derangement of joint
719.0	9	Effusion of joint
719.1	9	Hemarthrosis
719.4	9	Pain in joint
719.5	9	Stiffness of joint not elsewhere classified
719.6	9	Other symptoms referable to joint
719.7	9	Difficulty in walking
719.8	9	Other specified disorders of joint
719.9	9	Unspecified disorders of joint
721	9	Spondylitis and allied disorders
722	9	Intervertebral disc disorders
723	9	Other disorders of cervical region
724	9	Other and unspecified disorders of back
727	9	Other disorders of synovium tendon and bursa
729	9	Other disorders of soft tissues
733	9	Osteochondropathies
736	9	Other acquired deformities of limbs
737	9	Curvature of spine
738	9	Other acquired musculoskeletal deformity
800–829	9	Fractures
830–839	9	Dislocations
840–848	9	Sprains and strains of joints and adjacent muscles
925–929	9	Crushing injuries
M20–M25	10	Joint disorders
M43	10	Other deforming dorsopathies
M48	10	Other spondylopathies
M50	10	Cervical disc disorders
M51	10	Thoracic, thoracolumbar, and lumbosacral intervertebral disc disorders
M53	10	Other and unspecified dorsopathies, not elsewhere classified
M54	10	Dorsalgias
M67	10	Other disorders of synovium and tendon
S02–S03	10	Fractures, dislocations, and sprains of head
S07	10	Crushing injury of head
S12–S13, S16–S17	10	Fractures, dislocations, sprains, crushing and other injuries of neck
S22–S23, S28	10	Fractures, dislocations, sprains, crushing and other injuries of thorax
S32–S33, S38	10	Fractures, dislocations, sprains, crushing and other injuries of lumbar and pelvic regions
S42–S43, S46, S47	10	Fractures, dislocations, sprains, crushing and other injuries of shoulder
S52–S53, S56, S57	10	Fractures, dislocations, sprains, crushing and other injuries of arm
S62–S63, S66, S67	10	Fractures, dislocations, sprains, crushing and other injuries of wrist, hand, and fingers
S72–S73, S76, S77	10	Fractures, dislocations, sprains, crushing and other injuries of hip and thigh
S82–S83, S86, S87	10	Fractures, dislocations, sprains, crushing and other injuries of knee and lower leg
S92–S93, S96, S87	10	Fractures, dislocations, sprains, crushing and other injuries of ankle and foot