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# Military expenditures and health: a cross-national study, 1975-2000



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## Abstract

**Purpose** – Recent sociological research highlights the growth of military expenditures in hi-tech, capital-intensive armaments and technology. The purpose of this paper is to examine the impact of these capital-intensive expenditures on two related health outcomes: under-five mortality and life expectancy.
**Design/methodology/approach** – This research utilizes a series of cross-national panel models estimated for a diverse sample of developed and less-developed countries from 1975 to 2000.
**Findings** – The authors find that hi-tech military expenditures increase under-five mortality and reduce life expectancy over the period studied, by reducing the number and type of soldiers able to take advantage of increased health-related resources obtained in the military and indirectly, by increasing income inequality, which negatively impacts these health outcomes.
**Research limitations/implications** – This cross-national study should be supplemented by case studies to better understand the processes being examined.
**Practical implications** – The increase in capital-intensive military expenditures found worldwide reduces the total number of soldiers in the military and raises their enlistment requirements. This makes it difficult for people with limited human capital to take advantage of the military's traditional pathway for upward mobility. New pathways for mobility will have to be developed to avoid the creation of a new permanent underclass.
**Social implications** – There are significant social policy implications for the findings. Hi-tech military expenditures have a significant negative impact on the short- and long-term health outcomes of children and adults, in both developed and less-developed countries, which must be addressed by public policy planners.
**Originality/value** – This is one of a handful of sociological studies on the impact of military establishment on society. These findings highlight the importance of "bringing the military back in" to the forefront of sociological research.

**Keywords** Public health, Disadvantaged groups, Health services, Political economy, Social policy

**Paper type** Research paper

## Introduction

After an absence of more than four decades, there has been a resurgence of empirical work on the impact of the military on various aspects of society, including economic growth, income inequality, and the environment. Our study continues this effort, focusing on the impact of military expenditures on two related health outcomes: under-five mortality and life expectancy. We begin with a review of the extant literature on the impact of the military establishment, enabling us to develop four hypotheses regarding the military expenditures/health relationship. We test these hypotheses with a cross-national panel analysis of 63-72 countries for the 1975-2000 time period. We focus on one particular aspect of military spending, that of capital-intensive, high-tech expenditures. We do so because there has been a global shift toward reliance on high-tech equipment, rather than personnel, over the period in question.

Fast forwarding to our results, we find that these high-tech military expenditures increase under-five mortality and reduce life expectancy, in wealthy and poor countries alike. The findings have significant policy implications, which we consider in the conclusion section of the paper.

## Military expenditures and economic growth

The debate regarding the impact of military expenditures on economic growth, the "guns or butter" question, continues without resolution after nearly 50 years of investigation.

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The military is seen by some as a modernizing force (Benoit, 1973; Bienen, 1971). From a Keynesian perspective, military expenditures expand demand and employment (Baran and Sweezy, 1968; Kidron, 1970; Benoit, 1973; Bluestone and Havens, 1986). Military spending also generates innovations and technological spinoffs in the national economy (Benoit, 1973; Deger, 1986; Chowdhury, 1991). An alternative perspective is offered by dependency and political economy theorists, who argue that military expenditures inhibit economic growth (Kaldor, 1976; Eide, 1976; Albrecht, 1977; Lock and Wulf, 1977; Senghaas, 1977; Wolpin, 1977; Abell, 1994; Levy, 1998) in part by competing with the civilian economy for both labor and capital (Russett, 1979; Samuelson, 1979; Knight *et al.*, 1996).

### Military and inequality

The military is also seen as an equalizing force in sociology, by expanding human capital through education and technical training (Andreski, 1968; Lenski and Nolan, 1984). Empirical findings generally support this argument (Garnier and Hazelrigg, 1977; Chan, 1989; Kentor, 1998; Kick *et al.*, 2006; Graeff and Mehlkop, 2006), although there is some evidence to the contrary (Cutright, 1967; Weede, 1993).

There are relatively few studies and even less consensus on the impact of military expenditures on income inequality. Abell (1994) found that military expenditures increased income inequality in the USA post-Viet Nam era. Abell argued that this was due to pay differentials between the military and civilian sectors, which are mediated by a shift to a hi-technology, capital-intensive military. Labor in hi-tech industries is relatively high paid (Melman, 1974). However, hi-tech expenditures generate relatively fewer employment gains, especially for those who do not possess sufficient education or skills to work in the defense industry or related research activities (Carson, 1987). Ali and Galbraith (2003), in a cross-national panel study between 1987 and 1997, find that military expenditures increase wage inequality. They hypothesize that this is due to the reallocation of resources away from social programs in education and health that have an equalizing effect on society (see also Vadlamannati, 2008). Ali and Galbraith (2003, p. 2) also note the potential impact of what they refer to as "equipment-intensive" militaries, suggesting that spending in this area might reduce the mitigating effects of a labor-intensive military on inequality. More recently, Lin and Ali (2009) utilize a panel Granger non-causality test on 58 countries from 1987 to 1999 and find no causal relationship between military expenditures and income inequality.

### Benefits of military participation

Service in the military brings a wide range of benefits, including higher levels of education, the acquisition of transferable skills, future employment, and higher incomes than non-veterans (Mangum and Ball, 1989; Angrist, 1998; Light, 1998; Hisnanick, 2003). This is especially true for minorities and other disadvantaged groups (Sampson and Laub, 1996; Bufford, 2003). More recent work suggests that the military provides a pathway for disadvantaged individuals out of resource-poor environments (Teachman and Tedrow, 2004). It is also suggested that the military enhances opportunities for expanded social networks (Hisnanick, 2003) and weak ties that improve opportunities for employment (Granovetter, 1973, 1974).

### High-tech military expenditures (military expenditures per soldier (MEPS))[1]

There is a growing literature that examines one aspect of military expenditures: spending on high-tech materials (e.g. Clark *et al.*, 2010; Jorgenson and Clark, 2009; Jorgenson *et al.*, 2010; Kentor and Kick, 2008; Kentor *et al.*, 2012). It is argued that this disaggregated component of overall military expenditures has a distinct impact on a host of outcomes. This new focus resonates with the admonitions of several researchers in this field, who suggest that a disaggregated approach will provide a more productive avenue for research in this area (Griffin *et al.*, 1982; Mintz and Hicks, 1984; Kick and Sharda, 1986; Kentor and Kick, 2008).

Military establishments worldwide are becoming increasingly capital intensive (Abell, 1990; Cody, 2005; Kentor and Kick, 2008; Myers, 2004). This component of military expenditures has been operationalized as "military expenditures per soldier (MEPS), which reflects a military's capital intensiveness" (Kentor, 2004). Kentor *et al.* (2012) report that these hi-tech expenditures doubled on average in a broad sample of 83 countries from 1970 to 1999, while the number of military personnel actually declined slightly. Capital-intensive militaries require more educated, but fewer, personnel. As a result, they have instituted increased entry requirements, excluding those without the necessary education and skills. No longer able to take advantage of this pathway of upward mobility and, without other institutional opportunities, individuals without the necessary human capital resources are unlikely to obtain the education and skills necessary to participate in an increasingly hi-tech civilian economy. Nor do they have access to the benefits provided to enlistees, both during and after active duty.

## Empirical studies of capital-intensive military expenditures

Comparative research on the impacts of capital-intensive militarization has gained momentum in recent years, focusing on economic growth, inequality, and the environment. In a cross-national study of developed and less-developed countries, Kentor and Kick (2008) report that hi-tech military expenditures inhibit economic growth, due in part to limiting labor force growth. The economies of less-developed countries are most affected by these hi-tech expenditures. In a follow-up cross-national study, Kentor *et al.* (2012) find that hi-tech military expenditures exacerbate household income inequality in both developed and less-developed countries. They argue that the higher induction requirements of capital-intensive militaries limit the ability of minorities and disadvantaged groups to access the benefits provided by military service and obtain subsequent employment in the civilian economy. This results in an increasing number of long-term unemployed and unemployable individuals.

Jorgenson *et al.* (2010) find that MEPS contributes to growth in national-level anthropogenic carbon dioxide emissions for both developed and less-developed countries. Similarly, Clark *et al.* (2010) focus on militarization and energy use, and find that nations with higher levels of MEPS consume greater amounts of fossil fuels. Jorgenson and Clark's (2009) panel study of the ecological footprints of nations identifies a strong positive association between such consumption-based environmental pressures and MEPS. Capital-intensive militaries are likely to increase their material infrastructure or become more spatially dispersed, which requires increased consumption of natural resources and land use (Jorgenson *et al.*, 2012).

Having explored the relevant literature on military spending, we turn now to the question at hand: the impact of military expenditures on health outcomes.

## Military expenditures and well-being

There is a broad literature on the impact of military service and expenditures on health and education.

### *Resource allocation (trade-offs)*

It is argued by many that there is an adversarial relationship between military spending and social spending. It is thought that these areas compete with each other for resources. This argument, referred to as "resource allocation" or "opportunity costs," goes as far back as Adam Smith (1937). Wolpin (1986) argues that exceptionally large military expenditures in less-developed countries have lowered living standards. Empirical studies are equivocal. Russett (1982) finds no "trade-offs" between military spending and health and education expenditures in the USA from 1941 to 1979. Harris (1986) also find no support for trade-offs in 12 Asian countries between 1967 and 1982. However, a number of researchers do find evidence for the trade-off hypothesis. Debalko and McCormick (1984) find significant, but weak, negative effects of military expenditures on public health and education. In a budgetary trade-off study of 13 Latin American countries, Looney (1986) reports a negative relationship between defense expenditures and social welfare spending. Dixon and Moon (1986), in a cross-national study of 116 countries, find that military spending inhibits social welfare outcomes, while military participation has a positive impact on these outcomes. Adeola (1996) reports a positive relationship between military expenditures and education spending, but a negative effect of military spending on health and social outcomes for a sample of 60 developing countries in 1985. Gifford (2006) finds that countries with large standing militaries spend less on social well-being. Conversely, countries with conscription exhibit greater spending in these areas.

*Under-five mortality and life expectancy*

Woolhandler and Himmelstein (1985) find that military expenditures increase under-five mortality in a cross-national study of 141 countries in 1979. Arms imports may also exacerbate under-five mortality (Kick *et al.*, 1990). Carlton-Ford (2010) reports mixed effects of military expenditures on child mortality rates, with significant interaction effects with the presence of armed conflict. Conversely, military participation appears to reduce under-five mortality (Bullock and Firebaugh, 1990; Kick *et al.*, 1990). London and Wilmoth (2006), however, find no evidence that military participation affords any mortality benefits.

*Military expenditures, income inequality, and health*

As noted earlier, recent empirical studies suggest that MEPS may increase income inequality (Kentor *et al.*, 2012). There is a substantial literature suggesting that income inequality may adversely affect health outcomes. Initial research in this area found a negative relationship between income inequality and health outcomes, including under-five mortality (Pampel and Pillai, 1986; Wagstaff and Van Doorslaer, 2000) and life expectancy (Wilkinson, 1992, 1996; Lobmayer and Wilkinson, 2000). More recent studies tended to dismiss these claims as artifactual (i.e. Deaton, 2003; Beckfield, 2004). Current research, however, appears to reaffirm the earlier findings (Wilkinson and Pickett, 2006; Babones, 2006). Wilkinson and Pickett's (2006) review of the literature provides a comprehensive picture of the state of this research. Wilkinson and Pickett reviewed the findings of 168 analyses of the relationship between income distributions and health outcomes. According to their findings, 70 percent of these analyses indicate that societies with larger income differences have poorer health. If the analyses are restricted to metropolitan areas or larger and studies with problematic control variables are excluded, only 6 percent of the remaining 128 analyses would be considered "unsupportive." Two subsequent articles support this position. In a cross-national study of 126 countries, Dorling *et al.* (2007) report a significant influence of income inequality on mortality, especially for younger adults, and conclude that "social inequality seems to have a universal negative impact on health." Finally, Karlsson *et al.* (2010) find in their cross-national study of 21 countries a negative relationship between income inequality and self-reported health for data collected in 2006.

## The impact of hi-tech military expenditures on health: four hypotheses

The above literature review provides the groundwork for the following four propositions that will be tested in subsequent analyses:

(1) Direct effect of hi-tech expenditures: the military provides various health benefits for its personnel and their families. This includes physical conditioning, improved nutrition, medical care, and health education for the enlistee and her/his family as well as access to Veterans Administration benefits in subsequent years. It also provides education and technical skills that enable disadvantaged individuals to obtain employment in the civilian sector, with higher lifetime wages than non-veterans. Therefore, excluding those who most benefit from military enlistment and who could not otherwise obtain them would have a negative impact on overall health outcomes. So our first hypothesis is that increases in MEPS would have a negative impact on health outcomes, both short and long-term, by denying those without the necessary human capital access to military employment.

(2) Opportunity costs: a second argument is that overall military expenditures compete with civilian expenditures for overall government expenditures. From this perspective, increases in military expenditures reduce government expenditures in social services. Reductions in social services will have a deleterious impact on the overall health of a country's population.

(3) International political economy (arms imports): the militaries in less-developed countries may be "encouraged" by the few large military arms exporting countries to become more capital-intensive, driving up their arms expenditures and exporting capital that might otherwise be used for social welfare.

(4) Inequality: recent findings indicate that hi-tech military expenditures increase income inequality. The literature further suggests that inequality may negatively impact health. Therefore, our final hypothesis is that hi-tech military expenditures may have an indirect negative effect on health outcomes, via the positive effect of MEPS on income inequality.

With our hypotheses in place, we now proceed with our empirical analyses.

## Methods and data

*Cross-national design*

This study employs a cross-national design. The strength of this methodology is in the identification of consistent, systematic relationships across a broad geography of countries that vary widely in terms of economic systems, level of development, social supports, educational policies, inequality, etc., providing some assurance that these findings reflect more than idiosyncratic events. This strength is also its weakness, in that it precludes a clear understanding of how these dynamics operate in any given country. For that, case studies are required. Those would be a valuable addition to our understanding of the processes in question.

*Two-way fixed effects (FE) models and ordinary least squares (OLS) cross-sectional models*

We use a pooled-time series of cross-sections panel data set design and employ the "xtregar" suite of commands in Stata software (Version 11) to estimate two-way FE models with the within estimator (Allison, 2009). This is one of the most commonly used methods in the comparative social sciences – including comparative sociology, because it addresses the problem of heterogeneity bias (Halaby, 2004). Heterogeneity bias in this context refers to the confounding effect of unmeasured time-invariant variables that are omitted from the regression models. To correct for heterogeneity bias, FE models control for omitted variables that are time invariant but that do vary across cases. This can be done by estimating unit-specific intercepts, which are the fixed-effects for each case. With the "xtreg" suite of commands in FE are estimated with the within estimator, which involves a mean deviation algorithm for the dependent variable and each time-varying independent variable. We also include unreported period-specific intercepts (i.e. "year dummies"). Therefore, these are two-way FE models. FE models are quite appropriate for this type of cross-national panel research because time-invariant unmeasured factors could affect human well-being outcomes. The FE approach also provides a stringent assessment of the relationships between the time-variant predictors and outcomes, given that the associations between them are estimated net of unmeasured between-country effects. Overall, this modeling approach is quite robust against missing control variables and more closely approximates experimental conditions than other model estimation techniques (Hsiao, 2003). In all FE models we include a correction for first-order autocorrelation (i.e. AR(1) correction), which was determined necessary through diagnostic tests (Greene, 2000; Wooldridge, 2002).

Due to data availability limitations for an important income inequality control variable, in the final series of reported analyses we employ OLS regression with robust standard errors.

All variables are transformed into logarithmic form and thus all reported regression models estimate elasticity coefficients[2]. The coefficients of an elasticity model are relatively easy to interpret. Specifically, the coefficient for each independent variable in such a model is the estimated percentage change in the dependent variable associated with a 1 percent increase in the independent variable, controlling for all other factors in the model.

*The data set*

For many of the reported model estimates, we analyze a balanced panel data set, consisting of observations at five-year increments from 1975 to 2000 for 72 nations. We include countries where data are available for both outcomes and the key independent variables at each of the included time points, and the independent variables are lagged five years relative to the dependent variables. Due to limited data availability for some of the additional controls, several of the tested FE models for both dependent variables include unbalanced panel datasets with less than 72 nations. We remind readers that since we include an AR(1) correction, the reported overall sample sizes and mean numbers of observations per country in the estimated models are reduced, the former by the number of countries in the data set, and the latter by a value of 1.

In the final series of reported analyses that employ OLS regression with robust standard errors, the number of countries is reduced to 41 with an average of 1.3 observations per nations.

Table I lists all the countries included in the analyses.

*Variables*

We first describe the two dependent variables, followed by descriptions of the independent variables in the order they are introduced into the estimated models.

*The dependent variables*. The first dependent variable is average life expectancy, which indicates the average number of years a newborn would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. These data are obtained from the World Bank (2007), and are derived from male and female life expectancy at birth. The World Bank obtains male and female life expectancy data from United Nations Population Division, census reports and other statistical publications from national statistical offices, Eurostat: demographic statistics, Secretariat of the Pacific Community: Statistics and Demography Program, and US Census Bureau: International Database.

| | |
|---|---|
| Algeria | Kuwait |
| Argentina | Luxembourg |
| Australia | Madagascar |
| Austria | Malawi |
| Bangladesh | Malaysia |
| Belgium | Mexico |
| Bolivia | Morocco |
| Brazil | Nepal |
| Burundi | The Netherlands |
| Cameroon | New Zealand |
| Canada | Nicaragua |
| Chile | Nigeria |
| Colombia | Norway |
| Cyprus | Oman |
| Denmark | Pakistan |
| Dominican Republic | Panama |
| Ecuador | Peru |
| Egypt | Philippines |
| El Salvador | Portugal |
| Finland | Rwanda |
| France | Senegal |
| Ghana | South Africa |
| Greece | Spain |
| Guatemala | Sri Lanka |
| Hungary | Sweden |
| India | Syrian Arab Republic |
| Indonesia | Thailand |
| Iran | Togo |
| Ireland | Tunisia |
| Israel | Turkey |
| Italy | UK |
| Jamaica | USA |
| Japan | Uruguay |
| Jordan | Venezuela |
| Kenya | Zambia |
| Republic of Korea | Zimbabwe |

**Table I.**
Countries included in the analyses

The second dependent variable, which we obtain from the same source as the first dependent variable, is under-five mortality rate. This measure refers to the probability of a child dying between birth and the age of five, if subject to current age-specific mortality rates, and is expressed per 1,000 live births. The World Bank obtains these data from the Inter-agency Group for Child Mortality Estimation.

*The independent variables*. We employ MEPS in the subsequent analyses. MEPS is calculated by dividing total military expenditures by total military personnel. Total military personnel estimates are gathered from the World Bank (2007) and total military expenditures are obtained from the Stockholm International Peace Research Institute (SIPRI) (1977/1984/1987/1991/2000). Military expenditures include all current capital expenditures on the armed forces, including peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces, if these are judged to be trained and equipped for military operations; and military space activities. More specifically, such expenditures include operation and maintenance; procurement; military research and development; military and civil personnel, including retirement pensions of military personnel and social services for personnel; and military aid (in the military expenditures of the donor country). Military personnel are active duty military personnel as well as paramilitary forces if the training, organization, and equipment suggest they may be used to support or replace regular military forces.

Gross domestic product (GDP) per capita in constant 2000 US dollars is included to control for level of economic development. These measures of economic development are obtained from the World Bank (2007).

We include two additional military variables: military expenditures as percent GDP and military participation rate. Military expenditures as percent GDP are obtained from the World Bank (2007), who use SIPRI's military expenditures data along with total GDP data in constant US dollars to calculate the measures. Military participation rate is a ratio of the number of military personnel per 1,000 population. To calculate military participation, we use the World Bank's (2007) military personnel estimates and total population data.

We control for fertility rate, which is a common predictor in models of under-five mortality and average life expectancy. The measure of fertility rates, which we obtain from the World Bank (2007), represent the average number of children that would be born to a woman if she were to live to the end of her child-bearing years and bear children in accordance with current age-specific fertility rates.

Exports as percent total GDP is included to control for a country's level of integration in the world economy. These data are obtained from the World Bank (2007).

Primary education is included as a measure of human capital, and is the total primary school enrollment (both sexes), regardless of age, expressed as a percentage of the primary school-aged population. The values can be over 100 percent due to the inclusion of overage and underage students in enrollment statistics. We obtain these data from the World Bank (2007), who gathers them from the United Nations Educational, Scientific, and Cultural Organization Institute for Statistics.

Doctors per 1,000 is included as a control variable, and includes graduates of a school of medicine who are working in any medical field (including teaching, research, and practice) per 1,000 individuals. We obtain these data from the World Bank (2007), who gathers them from the World Health Organization.

We employ a gini coefficient with a potential range of values from zero to 100 that measures household income inequality. These data are obtained from the University of Texas Inequality Project (http://utip.gov.utexas.edu/data.html). The data set is readily downloadable, and labeled as EHII (i.e. estimated household income inequality data set)[3]. Recent studies in the social sciences that employ the EHII income inequality data include Galbraith (2009), Jen *et al.* (2008), Kentor *et al.* (2012), and Meschi and Vivarelli (2009).

Arms imports as percent of total GDP includes the supply of military weapons through sales, aid, gifts, and those made through manufacturing licenses. Data cover major conventional weapons such as aircraft, armored vehicles, artillery, radar systems, missiles, and ships designed for military use. Excluded are transfers of other military equipment such as small arms and light weapons, trucks, small artillery, ammunition, support equipment, technology transfers, and other services. Arms import data are initially obtained from World Bank (2007) and are reported in constant 1990 US dollars. We use total GDP data in constant 2000 US dollars (World Bank, 2007) to create the measure of imports as percent of total GDP.

Health expenditures as percent of total GDP, which we obtain from the World Bank (2007), refer to the sum of public and private health expenditures as percent of GDP, and covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health.

We include income share held by lowest 10 percent as an additional measure of income inequality. These data, which we obtain from the World Bank (2007), are limited in their availability and thus models that employ them are estimated with OLS regression.

There is substantial variation in these variables across the countries included in the analyses. In 1980, For example, The USA had a per capita income of US$36,450, life expectancy of about 77 years, and under-five mortality rate of 8 per 1,000. In contrast, Malawi in 1980 had a per capita income of US$156, life expectancy of 44 years, and under-five mortality rate of 174 per 1,000. There were 0.25 physicians per 1,000 in Malawi, compared to 1.5 physicians per 1000 in the USA. Income inequality was a different story. The income share held by the lowest 10 percent of the population in 1980 was 1.8 percent in the USA, 2.0 percent in Rwanda, and 2.5 percent in Canada. Military expenditures have the greatest range across countries. In 1980, the USA spent about 265 billion dollars on defense, while the next largest spender, the U.K, spent 49 billion dollars. The difference is more dramatic today. US military expenditures were 596 billion dollars in 2015, compared to 55 billion dollars in the UK.

Descriptive statistics and pairwise bivariate correlations for all variables included in the analyses are provided in Table II.

## Analyses

The following analyses estimate the direct and indirect effects of capital-intensive military expenditures on under-five mortality and average life expectancy as specified in our four hypotheses above. The first set of analyses (Table III) examines the direct impact of these expenditures on our health outcomes as detailed in the first hypothesis. In the next two steps (Tables IV and V), we assess the mediating effects of opportunity costs, arms imports, and income inequality identified in second and fourth hypotheses. The FE panel methodology described above is used in Tables III and IV. However, OLS models are reported in Table V due to data limitations.

## Results

We turn now to the results. Unstandardized coefficients (flagged for statistical significance) as well as their *t*-statistics (absolute values) are reported. For the FE models, we provide $R^2$ within and $R^2$ overall values (also reported for the OLS models), and for all estimated models we also report the number of countries, mean observations per country, and overall sample size.

The results in Table III indicate that MEPS negatively affect life expectancy and positively affect under-five mortality rates. Three models are examined for each health outcome. Model A includes only MEPS and GDP per capita. Model B adds the military participation rate and total military expenditures/GDP controls. The remaining control variables of fertility rate, exports/GDP, primary education enrollments, and doctors per 1,000 are included in Model C. MEPS is statistically significant in all three models in the expected directions, with a positive effect on under-five mortality and a negative effect on life expectancy.

Turning to the control variables, GDP per capita positively affects average life expectancy and negatively affects under-five mortality rates in all models. Primary education levels and the number of doctors per 1,000 both positively affect life expectancy and negatively affect under-five mortality in their respective models. None of the other control variables have statistically significant effects on either health outcome[4].

The findings reported in Table IV address the indirect effects of capital-intensive military expenditures on health identified in the second, third and fourth hypotheses (resource allocation, arms imports, and income inequality). These models include MEPS as well as the other two military measures and GDP per capita. Each reported model for both outcomes also includes one additional predictor: domestic income inequality, measured as a gini coefficient (Model D), arms imports as percent of GDP (Model E), or health expenditures as percent of GDP (Model F). Military expenditures per solider continue to negatively affect

**Table II.**
Descriptive statistics and pairwise bivariate correlations

| | Mean | SD | *N* | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life expectancy | 4.17 | 0.17 | 432 | (1) | | | | | | | | | | | |
| Under-five mortality | 3.68 | 1.16 | 432 | (2) | −0.88 | | | | | | | | | | |
| Military expenditures per soldier | 9.48 | 1.31 | 432 | (3) | 0.64 | −0.73 | | | | | | | | | |
| GDP per capita | 7.78 | 1.55 | 432 | (4) | 0.83 | −0.89 | 0.87 | | | | | | | | |
| Military participation rate | 1.79 | 0.76 | 432 | (5) | 0.50 | −0.46 | 0.23 | 0.48 | | | | | | | |
| Military expenditures as % GDP | 1.33 | 0.60 | 432 | (6) | 0.05 | –.03 | 0.24 | 0.07 | 0.62 | | | | | | |
| Fertility rate | 1.29 | 0.54 | 432 | (7) | −0.79 | 0.91 | −0.64 | −0.80 | −0.34 | 0.11 | | | | | |
| Exports as % GDP | 3.16 | 0.64 | 432 | (8) | 0.32 | −0.34 | 0.28 | 0.32 | 0.16 | 0.05 | −0.21 | | | | |
| Primary education | 4.53 | 0.25 | 366 | (9) | 0.55 | −0.46 | 0.33 | –46 | 0.22 | −0.09 | −0.46 | 0.19 | | | |
| Doctors per 1,000 | 0.62 | 0.46 | 303 | (10) | 0.80 | −0.85 | 0.67 | 0.85 | 0.50 | 0.02 | −0.83 | 0.21 | 0.44 | | |
| Health expenditures as % GDP | 1.38 | 0.48 | 144 | (11) | 0.58 | −0.72 | 0.61 | 0.74 | 0.27 | −0.08 | −0.66 | 0.16 | 0.31 | 0.77 | |
| Income share held by lowest 10% | 1.12 | 0.33 | 54 | (12) | 0.02 | −0.27 | 0.21 | 0.13 | 0.03 | 0.10 | −0.22 | 0.17 | −0.39 | 0.07 | 0.14 |

**Note:** All variables are logged (ln)

| | LE Model A | LE Model B | LE Model C | UFM Model A | UFM Model B | UFM Model C |
|---|---|---|---|---|---|---|
| Military expenditures per soldier | −0.03*** (4.59) | −0.03*** (4.04) | −0.03* (2.17) | 0.06** (2.79) | 0.07** (3.16) | 0.06**** (1.88) |
| GDP per capita | 0.04** (2.65) | 0.04* (2.40) | 0.06**** (1.75) | −0.37*** (6.79) | −0.38*** (6.78) | −0.34*** (3.96) |
| Military participation rate | | 0.01 (0.23) | 0.01 (0.07) | | 0.05 (1.46) | −0.07 (1.11) |
| Military expenditures as % GDP | | −0.02 (1.04) | 0.01 (0.01) | | 0.03 (0.59) | −0.14 (1.55) |
| Fertility rate | | | −0.02 (0.33) | | | 0.19 (1.49) |
| Exports as % GDP | | | 0.01 (0.02) | | | 0.04 (0.74) |
| Primary education | | | 0.10* (1.98) | | | −0.22**** (1.78) |
| Doctors per 1,000 | | | 0.11**** (1.93) | | | −0.52*** (3.62) |
| Constant | 4.12*** (34.31) | 4.14*** (32.70) | 2.50*** (10.78) | 5.85*** (14.94) | 5.67*** (13.78) | 6.75*** (8.12) |
| $R^2$ within | 0.37 | 0.37 | 0.28 | 0.82 | 0.82 | 0.84 |
| $R^2$ overall | 0.59 | 0.56 | 0.73 | 0.82 | 0.81 | 0.86 |
| Number of countries | 72 | 72 | 63 | 72 | 72 | 63 |
| Mean observations per country | 5.0 | 5.0 | 2.9 | 5.0 | 5.0 | 2.9 |
| $n$ | 360 | 360 | 182 | 360 | 360 | 182 |

**Notes:** Unstandardized coefficients flagged for statistical significance; absolute value of $t$-statistics in parentheses. All models include unreported period-specific intercepts; all variables except year dummies are logged. LE, life expectancy; UFM, under-five mortality. $^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; $^{****}p < 0.10$ (two-tailed)

**Table III.** Coefficients for the regression of life expectancy and under-five mortality on selected independent variables: two-way fixed effects model estimates with AR(1) correction for 63-72 countries, 1975-2000

| | LE Model D | LE Model E | LE Model F | UFM Model D | UFM Model E | UFM Model F |
|---|---|---|---|---|---|---|
| Military expenditures per soldier | −0.03*** (3.99) | −0.01**** (1.78) | −0.02 (1.64) | 0.05**** (1.92) | 0.07** (2.60) | 0.09* (1.96) |
| GDP per capita | 0.05** (3.08) | 0.01 (0.33) | 0.06 (1.24) | −0.33*** (4.98) | −0.28*** (4.40) | −0.83*** (5.37) |
| Military participation rate | −0.01 (0.48) | 0.02**** (1.90) | 0.03 (1.42) | 0.03 (0.69) | −0.01 (0.12) | 0.05 (0.67) |
| Military Expenditures as % GDP | −0.02 (0.97) | −0.03 (0.95) | −0.01 (0.05) | −0.01 (0.07) | 0.19**** (1.70) | 0.04 (0.45) |
| Domestic income inequality | 0.01 (0.48) | | | −0.01 (0.36) | | |
| Arms imports as % GDP | | −0.01 (0.42) | | | −0.01 (0.12) | |
| Health expenditures as % GDP | | | −0.01 (0.15) | | | −0.05 (1.23) |
| Constant | 3.99*** (27.41) | 4.20*** (33.69) | 3.89*** (10.04) | 5.89*** (10.02) | 5.42*** (11.03) | 9.17*** (7.61) |
| $R^2$ within | 0.48 | 0.59 | 0.37 | 0.83 | 0.88 | 0.18 |
| $R^2$ overall | 0.65 | 0.12 | 0.89 | 0.79 | 0.72 | 0.68 |
| Number of countries | 70 | 68 | 72 | 70 | 68 | 72 |
| Mean observations per country | 4.1 | 4.2 | 2 | 4.1 | 4.2 | 2 |
| n | 288 | 287 | 144 | 288 | 287 | 144 |

**Notes:** Unstandardized coefficients flagged for statistical significance; absolute value of $t$-statistics in parentheses. All models include unreported period-specific intercepts; all variables except year dummies are logged. LE, life expectancy; UFM, under-five mortality. Model F for both outcomes includes observations for only 1995 and 2000 and does not include an AR(1) correction; $p$-value for military expenditures per soldier in LE Model F is 0.106. $^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; $^{****}p < 0.10$ (two-tailed)

**Table IV.** Coefficients for the regression of life expectancy and under-five mortality on selected independent variables: 2-way fixed effects model estimates with AR(1) correction for 68 to 72 countries, 1975-2000

life expectancy and positively affect under-five mortality in all but one Model (F). In this model, the $p$-value for the estimated effect of military expenditures per solider on life expectancy when controlling for health expenditures is slightly above the 0.10 significance level, but this may be due to limited data availability for health expenditures, the sample size and mean number of countries for this estimated model are largely reduced. The estimated effects of the other two military variables and GDP per capita are generally consistent with the analyses reported in Table III. However, the estimated effects of health expenditures, arms imports, and income inequality (gini coefficient) on both health outcomes are all non-significant, providing no support for second, third and fourth hypotheses.

The final set of results, reported in Table V, assesses the mediating effect of a different aspect of income inequality: the income share held by the lowest 10 percent of the population. As a reminder, sufficient data for this variable are not available to perform FE panel analyses, so OLS models with robust standard errors are estimated instead. For direct comparison, we also report baseline models for both outcomes (that include MEPS, GDP per capita, and the other two military variables) restricted to the same reduced sample as the models that introduce the alternative inequality measure.

In these models, the estimated effects of MEPS on both health outcomes remain statistically significant and in the expected directions. The newly introduced income inequality measure, the income share held by the lowest 10 percent of the population, also has a significant negative effect on under-five mortality rates, but is not significant in the life expectancy models[5]. Total military expenditures/GDP increase under-five mortality, but have no effect on life expectancy. GDP per capita continues to have a positive effect on life expectancy and a negative effect on under-five mortality. While these results are supportive of a mediating role of income inequality, they must be considered tentative, given these models do not include FE and the relatively small number of cases.

## Discussion and conclusion

The reported findings support the central proposition of this study: hi-tech, capital-intensive military expenditures have adverse effects on under-five mortality and life expectancy over the period in question, net of relevant control variables. Our most robust findings are direct adverse effects of these capital-intensive expenditures on both health outcomes. We also find tentative support for the mediating role of income inequality on under-five mortality. We find no support for propositions concerning mediating roles of resource allocation or arms imports. We argue that the shift to a hi-tech, capital-intensive military reduces the overall need for military personnel while increasing the human capital requirements of enlistees, effectively limiting the ability of those without the requisite education and skills to obtain entry. These disadvantaged individuals are thereby denied access to the many benefits afforded military personnel and their families, including education and technical

**Table V.** Coefficients for the regression of life expectancy and under-five mortality on selected independent variables: OLS model estimates with robust standard errors for 41 countries, 1975-2000

| | LE Model G | LE Model H | UFM Model G | UFM Model H |
|---|---|---|---|---|
| Military expenditures per soldier | −0.04* (1.73) | −0.04**** (1.67) | 0.23* (1.79) | 0.27** (1.98) |
| GDP per capita | 0.11*** (4.73) | 0.11*** (4.74) | −0.91*** (8.21) | −0.93*** (7.63) |
| Military participation rate | −0.01 (0.30) | −0.01 (0.31) | 0.01 (0.01) | 0.02 (0.12) |
| Military expenditures as % GDP | 0.04 (0.30) | 0.02 (0.16) | 1.60* (1.99) | 1.16**** (1.48) |
| Income share held by lowest 10% | | −0.01 (0.62) | | −0.52*** (2.83) |
| Constant | 3.69*** (29.41) | 3.70*** (30.27) | 8.41*** (12.62) | 8.71*** (13.86) |
| $R^2$ overall | 0.65 | 0.65 | 0.83 | 0.86 |
| Number of countries | 41 | 41 | 41 | 41 |
| Mean observations per country | 1.3 | 1.3 | 1.3 | 1.3 |
| *n* | 54 | 54 | 54 | 54 |

**Notes:** Unstandardized coefficients flagged for statistical significance; absolute value of *t*-statistics in parentheses. LE, life expectancy; UFM under-five mortality; all variables are logged. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$ (two-tailed); ****$p < 0.10$ (one-tailed) skills training, health benefits both during and after active service, increased lifetime income and, more broadly considered, a bridge or pathway out of their resource-poor environments. The inability to access these benefits has a direct adverse impact on the health of the individual and her/his family.

There may be an indirect dynamic as well. Previous research indicates that this move to hi-tech militaries increases income inequality, by restricting the military's traditional role of pathway of upward mobility for disadvantaged people (Kentor *et al.*, 2012). Our results suggest that this increased inequality leads to increased under-five mortality over the period studied. This finding also contributes to the broader debate on the impact of income inequality on health.

It is important to note that these dynamics are not confined to wealthy countries alone. We find that the relationship between hi-tech military expenditures and health exists in countries at all levels of development, and its continued growth (Kentor *et al.*, 2012), will likely exacerbate this effect over time. Our findings, along with other recent studies, give increasing awareness to the negative impacts of the military on many outcomes, including economic development (Kentor and Kick, 2008), the environment (Jorgenson *et al.*, 2010; Jorgenson *et al.*, 2012), and income distribution (Kentor *et al.*, 2012).

The policy implications of our study are significant. Our results suggest that capital-intensive militaries no longer afford the disadvantaged with a pathway of upward mobility. This may be the only major avenue available for these individuals in many nations, wealthy and poor alike. It does not seem unreasonable to ask why it is that many nations, including the USA, provide disadvantaged people no alternatives to military service to better their lives and the lives of their families. And to the extent that this pathway has been closed, what (if any) institutional structures will replace it? It is surprising perhaps to realize that an entire country's health is significantly impacted by policy changes in militaries that enlist only a small fraction of the total population. Evidently, the military's historical role as a pathway of upward mobility is a powerful one, not only for those directly affected, but for society as a whole. As Stanislav Andreski (1968) noted nearly a half-century ago, the military performs important and unintended functions in society, by bringing together people of widely differing economic, racial, ethnic, and educational backgrounds, a theme echoed more recently by Yarmolinsky (1971).

Some may respond to the findings herein and elsewhere by arguing that the purpose of the military is to protect its country and citizens from external threats, and that these unintended consequences are unfortunate but irrelevant to the military's mission. Perhaps, but these dynamics have broad, lasting impacts on society. Consequently, governments would do well to pay close attention to the unintended repercussions brought about by changes to this institution.

**Notes**

1. Some military scholars prefer to the use term "troop" instead of "soldier." However, the concept of "military expenditures per soldier" is commonly used in the sociological literature, so we continue this practice.

2. We note that results of sensitivity analyses available upon request where we estimate all models with the "unlogged" forms of the measures are consistent with the reported estimates.

3. More specifically, these data are estimates of gross household income inequality, computed from regression equations that consider the relationship between the commonly used Deininger and Squire (1996) inequality measures and UTIP's UNIDO pay inequality measures, controlling for the source characteristics in the Deininger and Squire data and for the share of manufacturing in total employment. The EHII measures are more appropriate for cross-national analyses of domestic income inequality than the commonly used Deininger and Squire measures since they include substantially more countries and yearly estimates, they account for changes over time and

differences across countries in pay dispersion, and the estimates are adjusted to household gross income as a references, and unexplained variations in the Deininger and Squire income inequality measures are treated as inexplicable and thus disregarded in the calculations.

4. In sensitivity analyses available upon request, we estimate the same models as reported in Tables III and IV for samples that exclude all developed countries as well as those that exclude just the USA. The estimated effects of MEPS on both health outcomes in the models for the reduced samples are substantively consistent with the reported findings.

5. In sensitivity analyses available upon request, we instead use measures of income share held by the lowest 20 percent of the population. The results are substantively identical with the reported findings, which should be expected since the two income measures are correlated above 0.9.

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