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Physical Fitness and Use-of-Force Performance for Police Students

The Impact of Body Height, Body Mass, Age, and Gender

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Abstract
All patrolling police officers, regardless of body composition, age, or gender, are expected to meet the physical challenges to which they are exposed. Some challenges can be extremely demanding, such as situations where officers must arrest an intractable subject. These situations might be influenced by the body height, body mass, age, and gender of the officer. This study aimed to explore relationships between these characteristics of forthcoming Danish police officers and their physical capacity (at a Physical Fitness Test – PFT) and their ability to handle an intractable subject during a Use-of-Force and Arrest Simulation Test (UFT). The study examines the impact of various physical characteristics on the performance of Danish police officers during a PFT and a UFT. It involved 646 Danish police students, and found that male students generally outperformed female students in both tests. Additionally, larger body composition conferred advantages to male students in the PFT, while larger body mass was disadvantageous for female students in both tests. Age negatively affected performance in the PFT for both genders. However, no correlation was observed between age and UFT performance. The findings underscore the importance of tailored training programmes early in police education to optimise performance in these tests.

Keywords
police, law enforcement, police use of force, body composition, age, gender

1. Introduction

1.1 Police work

While a substantial part of police work is sedentary, as noted by Anderson et al. (2001, p. 27) and Hälsohögskolan (2013, p. 17), it remains physically demanding. Anderson et al. (2001) outline a variety of physical tasks that an officer might encounter daily, such as walking, climbing, and handling suspects, each requiring differing levels of strength, cardiovascular fitness, and muscular endurance. This is supported by further research from Lagestad & van den Tillaar (2014a, p. 1394) and Marins et al. (2018a, p. 27), which emphasises the extensive physical capabilities required. Anderson et al. (2001, p. 27) assert that these physical requirements are consistent across all patrol officers, irrespective of body composition (body height and body mass), age, and gender. In the present study, we explore this exact relationship – whether there are connections between body composition, age, gender, and physical fitness, as well as the ability to cope with the physical demands of a use-of-force test, which can be a specific part of policing, among Danish police students.

1.2 Access to policing

In recent times, various police education programmes and authorities have endeavoured to ensure that the physical demands of the profession are met through compulsory admission requirements (see, for example, Lagestad, 2012, p. 322). These requirements encompass aspects related to gender, age limits, physical criteria, and physical fitness characteristics. Furthermore, to ensure that future police officers can cope with the physical demands of the job, these programmes have tested and monitored the physical capacities of their recruits, both during and as part of the final assessment of their education (Dillern et al., 2014a, p. 192; Lagestad & van den Tillaar, 2014a, p. 1395). In Denmark, applicants must be at least 21 years of age to apply for a police officer position. Until the end of 2007, there was a maximum age limit of 29 years for applicants. Currently, there are no gender-specific regulations, and the first women began their training at the Danish police academy in 1977.

In terms of body composition, there are no restrictions for applicants to the Danish police force. However, for the present paper (and in the period from 2004 to 2018) and the included sample of Danish police students, a minimum body height for applicants was set at 164 cm for women and 172 cm for men. Body mass has never been an exclusion criterion in Denmark. However, within a normal population, one can assume relationships between body height and body mass to exist, implying that body mass, at least implicitly, has functioned as a selection criterion in the Danish police education. Regarding physical capacities, there are physical fitness tests (PFTs) at both the point of application and examination, which prospective officers need to pass. These tests include elements of endurance, strength, power, and coordinative capabilities.

Historically, and in an international context, the conception of the police occupation as physically demanding has functioned as a strong condition in the police officer selection process. The image of policing as hard manual labour created an idea that certain specific and easily measurable physical and bodily features would increase the likelihood of performing the job satisfactorily. Through recruitment and admission criteria, it was ensured that certain levels of physical fitness were embodied in the police officers. Hence, the ideal, and what became manifested in practice, was a tall, strong, and athletic young man (Carlström, 1999, p. 103; Connell, 2002, p. 3). Based on this conception, one can see that being physically fit was not the only requirement for a position in the police. Both being "older" or being female were historically understood as such disadvantages in performing police work that they functioned as demarcation points to the force. The first was associated with bodily decay and degeneration alongside increased age (also actualised in relation to the police occupation; see, for example, Lagestad & van den Tillaar, 2014a), and the second was associated with unfavourable physical preconditions in females compared with males. Despite possible historical biases that may exist, as of June 2023, 19% of the total police officers in the Danish police force are women (Corporate Key Figures, 2023, p. 13).

1.3 Physical fitness, body composition, and the ability to handle the physical demands of policing

1.3.1 Physical fitness and policing

Different nations and forces subject recruits and officers to a range of different physical fitness tests. The primary aim of these tests is to evaluate the candidates' general physical attributes (Marins et al., 2019a, p. 2872). Although these tests do not directly correspond to the actual demands of policing, numerous studies reveal relationships between the general physical capacities measured by these tests and work-specific tests developed by various agencies (Beck et al., 2015, p. 2340; Lindsay et al., 2021; Lockie et al., 2018a; Marins et al., 2019b, p. 1836; Orr et al., 2021; Stanish et al., 1999, p. 669). A common and physically demanding work-related situation that may vary in intensity and duration occurs when police officers must use physical force to control an intractable subject (Anderson et al., 2001, p. 18; Arvey et al., 1992, p. 998; Dillern et al., 2014a, p. 2; Henriksen, 2020, p. 9; p. 13; Lagestad, 2012, p. 330; Silk et al., 2018).

1.3.2 Physical fitness and police use of force

Although exploring in vivo is complex, several studies indicate relationships between police officers' physical capacity and their performance in simulated arrest situations (Arvey et al., 1992, p. 1001; Dillern et al., 2014a, p. 2; Greenberg & Berger, 1983, p. 809). In Denmark, a study by Henze et al. (2022) revealed positive relationships between the physical capacity of police students measured by a PFT consisting of pull-ups, broad jump, bench press, and 2000-metre rowing on an ergometer and their ability to cope in a use-of-force and arrest simulation test. Currently, however, no Danish studies, and, to our knowledge, no international studies provide information about the relationship between body composition, age, and gender of police students and their performance in police-specific situations of high physical exertion or in physical tests in the same study.

1.3.3 Challenges in researching police physical demands

There are several reasons why research on this topic has been limited. Quantifying and studying the diverse physical tasks that officers perform across different roles, units, and jurisdictions is complex, since the duties of the officers can vary significantly. There are constantly evolving job demands, technologies, and policies, which further complicate longitudinal research on police work. However, there is a general recognition that policing is physically demanding, involving potential confrontations and physical workload (Orr et al., 2020, 2021). Police organisations did not focus on how body composition, age, and gender as a coherent construct influences the performances of police students.

1.4 Research objectives

The main objective of this study is to establish normative data on the bodily characteristics of police students (body composition, age, and gender) and to explore how these characteristics relate to the students' performance in a PFT. Furthermore, we aim to examine how these characteristics influence the police students' ability to handle a constructed test of work-related physical demands in policing, as demonstrated through their performance assessed by a use-of-force test (UFT).

Research questions:

- How do body height, body mass, age, and gender of police students relate to their performance on the PFT?
- To what extent do the bodily characteristics of police students influence their ability to handle occupation-specific demands of physical exertion, as measured by the UFT?
- Are there significant differences in PFT and UFT performance between male and female police students, and how do these differences relate to their physical characteristics?

Research hypotheses:

- Police students with a larger body height and body mass will perform better on the PFT and UFT compared to those with a smaller body height and body mass.
- Older police students will perform worse on the PFT and UFT compared to younger police students.
- Male police students will outperform female police students on the PFT and UFT.

2. Methods

2.2 Participants and design

This study is based on data collected at the Danish National Police College in 2016 and 2017, involving the participation of 646 students (124 females and 522 males). With a descriptive correlational design, the participating students completed a PFT, which comprised four test elements, and a UFT, wherein their ability to apply use-of-force techniques to an intractable subject was evaluated. All tests were administered on the premises of the police college at the end of the students' eight-month tenure. Before the PFT, the students had undergone forty hours of physical education and training, including an initial PFT to ensure their familiarity with the test protocol. Similarly, the students received sixty hours of use-of-force training, which included familiarisation with the UFT protocol, before carrying out the test. This minimised any additional risk beyond the usual scope of their training. In addition, the students' body composition (body height and mass), age, and gender were collected. To protect the privacy of the students, all data were analysed anonymously.

All students provided their consent to participate in this study, which was conducted in accordance with the Danish Code of Conduct for Research Integrity (Ministry of Higher Education and Science, 2014). The management of the Danish National Police College approved the study.

2.2 The physical fitness test (PFT)

The PFT protocol consisted of four elements, each designed to test different aspects of the students' physical capacity. These elements were executed sequentially, starting with pull-ups to evaluate upper-body pulling strength, followed by a broad jump (standing long jump) to assess lower-body power generation. This sequence was followed by a bench press to gauge upper-body pushing strength and concluded with a 2000-metre row on an ergometer (Concept2 model D) to measure cardiovascular capacity. The protocol has both historical and empirical origins and consists of elements that are prevalent in physical tests at police organisations (Massuça et al., 2022; Orr et al., 2021). The test protocol was conducted within a 90-minute timeframe, allowing students ample recovery time between test elements. The students' body mass was measured using an electronic scale (Seca Libra model 862), and they were given approximately 10 minutes to complete an individual warm-up routine.

The students' performance in each test element was evaluated by two certified assessors and graded on a seven-point scale (Ministry of Higher Education and Science, 2020). The procedures for the different tests were as follows:

2.2.1 Pull-up protocol for female students

The student grasped a boom, with a height of 17 cm, suspended horizontally approximately 83 cm from the ground. Using a pronated grip on the boom and with fully extended arms, the student placed her feet on a bench set at a height of 50 cm from the top of the boom, thereby suspending her body close to horizontally between the boom and the bench. From this starting position, the student executed a vertical pull-up until her chest made contact with the underside of the boom, after which she returned to the initial position again. During the test, the vertical speed of the hips was not permitted to exceed the vertical speed of the upper body to prevent kipping. The student was given one attempt to complete as many pull-ups as possible.

2.2.2 Pull-up protocol for male students

With a pronated grip on a bar or beam, the student hung with extended arms and a vertically outstretched body, ensuring no contact with the floor. From this position, the student executed a vertical pull until their chin was visibly above the bar, subsequently returning to the initial position. During the test, the vertical speed of the legs was not permitted to exceed that of the upper body to prevent kipping. The student was given one attempt to complete as many pull-ups as possible.

2.2.3 Broad jump protocol for both female and male students

The students positioned themselves with their feet parallel, standing behind the 0 cm mark on a custom-made broad jump mat, which was marked in 5 cm increments. From this stance, each student performed a forward jump. The distance of the jump was measured from the 0 cm mark to the heel that landed closest to this mark. Each student was allowed two attempts to achieve the maximum possible distance.

2.2.4 Bench press protocol for both female and male students

Lying on a bench press bench, the student gripped the barbell with a pronated grip and held the barbell with outstretched arms. From this position, the student lowered the barbell to the chest, after which it was returned to the initial position. This action was performed while maintaining contact between the bench and the gluteus maximus muscle, as well as between the bench and the upper back. The student was given one attempt to complete approximately 10 repetitions (with a valid range of 8–12 repetitions) using a maximum mass load of their choosing.

2.2.5 2000-metre rowing on an ergometer protocol for both female and male students

The student settled onto the Concept2 Model D rowing ergometer, selected the preferred damper and footplate settings, and then started. The student was given a single attempt to cover 2000 metres in the least possible time.

2.3 Use-of-force and arrest simulation test (UFT)

The UFT protocol comprised four elements, assessing the students' abilities to apply use-of-force and arrest techniques in situations mirroring real-life encounters with intractable subjects (Staller et al., 2017, p. 73). These elements were executed in succession, and the test protocol was completed within a 90-minute time frame, allowing students ample recovery time between test elements. Before the test, students were assigned to groups of three. Female students were evenly distributed among the groups, while male students were assigned randomly. Each student's performance in the individual test elements was evaluated by three experienced assessors and graded on a seven-point scale (Ministry of Higher Education and Science, 2020). Finally, an average grade was calculated based on the grades obtained in the individual test elements. By using three assessors, high inter-rater reliability was ensured, as they could calibrate their assessments against each other. Furthermore, the use of three assessors ensured that most of the techniques and choices of the participants and the aggressors could be monitored and included in the evaluation. Using three assessors also contributed to securing uniformity in the attackers' mode of attack throughout the test, as it enabled immediate feedback on whether their aggression level met the criteria. Additionally, a standardised and accurate test assessment was secured by the assessors undergoing a short educational programme on how to rate different performances and sessions. The assessors had, prior to testing, assessed some test trials to ensure the highest possible level of agreement. Although we have taken measures to ensure inter-rater reliability by using experienced and well-educated assessors, we have not examined the inter-rater reliability in their assessments specifically. The specific test elements were as follows:

2.3.1 Use of force standing and lying down on the ground

This element consisted of two successive scenarios in which two students alternately assaulted a third participant, varying in intensity and distance. The scenarios lasted for a total of five minutes and involved the assessed student defending themselves by blocking, evading, or counterattacking various strikes, kicks, grabs, neck locks, strangleholds, and mounts from either a standing or a grounded position. The student's performance was evaluated based on their ability to protect themselves without losing control and to strategically retreat to a more advantageous position using forceful means.

2.3.2 Use of baton

This element comprised a single round of one minute, in which two students alternately attacked a third student with varying intensity and range. The assessed student was required to block, evade, or counterattack a variety of strikes, kicks, and grabs from a standing position, with the objective of creating distance from the attacker and drawing, using, and, if necessary, defending their baton. The student's performance was evaluated based on their ability to maintain control while protecting themselves, the ability to retreat to a more tactically advantageous position, and the ability to use and defend the baton in accordance with current legislation.

2.3.3 Defence against a pointed weapon

This exercise entailed a two-minute round in which two students alternately assailed a third student, varying in intensity and distance. The student under evaluation was required to dodge or deflect the attacks, creating distance from the aggressor and managing the situation using forceful methods, such as pepper spray, baton, or a firearm. The assessment centred on the student's capacity to defend themselves without losing control, retreat to a tactically superior position, and deal with a presumed or identified bladed weapon using forceful methods.

2.3.4 Patrol collaboration

This element consisted of two consecutive scenarios in which two students collaborated to control a challenging subject. The scenarios lasted for a total of four minutes and involved the assessed students managing a subject who could display either calm or aggressive behaviour while standing or lying on the ground. The assessment of the students was conducted in relation to both their collaborative skills and their ability to handle the situation using control and takedown techniques in a tactically sound manner.

In evaluating all scenarios, students were assessed on their communication with both attackers and partners, handling pressure, using force proportionally, and maintaining distance and balance. The assessment also included maintaining a tactically advantageous position, balance during power transfers like pushes and strikes, and ensuring protective blocks prioritise the head and then the body.

3. Statistics

The data were first plotted in Excel and thereafter transferred to SPSS 28, where all statistical analyses were performed.

3.1 Preliminary analyses

Ten original variables were included in the SPSS dataset: body composition (body height in cm and body mass in kg), age, gender, and physical ability scores from tests of pull-ups (number of repetitions), broad jump (measured in cm), bench press volume (kg x repetitions), and 2000-metre rowing on an ergometer (measured in seconds). Additionally, a score on an arrest simulation test (UFT Summarised) and a variable summarising all the physical tests into a physical capacity score (PFT Summarised) were included.

Initially, all variables, except gender, were tested for normality. The Shapiro-Wilk's test revealed that none of the variables were normally distributed ($p \leq 0.05$). This was, to some extent, expected as the scores on the various physical tests and the arrest simulation test were related to different threshold values associated with goal achievement. Naturally, the variable scores would be distributed in clusters to a certain extent. Furthermore, both age, height, and mass are influenced by certain admission requirements for Danish police education, which are described earlier.

When interpreting these results, it is crucial to consider that a drawback of the Shapiro-Wilk test is its heightened sensitivity in large samples. As a result, in studies with large samples, like the current one, data should be evaluated through graphical representations, with meticulous attention to the distribution's skewness and kurtosis. According to the Normal Q-Q plots, all variables, except age, seemed to be acceptable. Age displayed a slight visible deviation from the normal line and was, thus, considered not normally distributed. The analyses of skewness and kurtosis further corroborated this; all variables, except for age (Kurtosis 4.01), fell within the acceptable range ($\leq \pm 2.0$), as per George and Mallery (2010). However, due to the aforementioned reasons, and the understanding that age, within a student population, would naturally not be normally distributed, we decided to include the age variable in subsequent analyses.

3.2 Main analyses and results

3.2.1 Normative data on physical capacities and body composition, age, and gender

To establish normative data and investigate gender disparities in the physical capacities and anthropometric characteristics of Danish police students, independent t-tests were conducted based on gender (Table 1). Regarding average scores across all variables, significant gender disparities were identified (with p<.001, except for age with p=.002). The extent of these disparities, according to Cohen (1988, pp. 284-287), was substantial (eta squared ≤.14) for all variables, except for age (which demonstrated a minor effect, eta squared =.01) and the UFT (which exhibited a moderate effect, eta squared =.08). The findings further suggested that males surpassed females in all individual physical tests, except for pull-ups, where the test procedure was not equivalent between the genders.

Table 1. Independent T-Tests Based on Gender

	Mean (SD)	t	df	Mean difference	95% CI	Eta squared
Body Height (in cm)	M 184.05 (5.86) F 170.44 (4.59)	28.23	232.70	13.61a	12.66 – 14.55	0.55
Body Mass (in kg)	M 85.57 (8.11) F 67.01 (6.66)	26.78	220.62	18.56a	17.20 – 19.93	0.53
Age	M 26.15 (3.54) F 25.22 (2.90)	3.06	220.22	.93b	.33 – 1.520	0.01
Pull-ups (repetitions)	M 12.45 (4.01) F 21.44 (6.90)	-14.07	145.57	-9.00a	-10.26 – -7.73	0.23
Broad Jump (in cm)	M 241.01 (17.00) F 197.25 (15.15)	26.51	656.00	43.77a	40.53 – 47.01	0.52
Bench Press (volume)	M 890.34 (139.85) F 517.30 (68.59)	43.33	400.83	373.05a	356.12 – 389.97	0.74
Rowing (in seconds)	M 129.30 (18.09) F 72.25 (20.44)	31.01	655.00	57.05a	53.44 – 60.67	0.59
PFT Summarised	M 22.51 (6.24) F 12.96 (3.21)	24.23	377.59	9.56a	8.78 – 10.33	0.47
UFT Summarised	M 4.33 (0.80) F 3.65 (0.95)	7.38	169.77	.68a	.50 – .86	0.08

The table shows the mean score, and the mean difference between genders, for all included variables.
M=males; F=females; N males=525-532; N females=125-126; a: p<.001; b: p<.05.
Broad jump and rowing were the only variables that met the assumption of equal variances, based on the Levene's test. For the other variables, equal variances are not assumed.

3.2.2 Correlation analyses

To explore the relationships between body composition (body height and mass), age, and other variables (four individual physical tests, use-of-force, arrest simulation test, and summarised physical score), we carried out bivariate correlation analysis. The results demonstrated that body height, body mass, and age correlated with several other variables (Table 2). We also examined these relationships separately for each gender (Tables 3 and 4). For female students, body mass exhibited a negative correlation with both the broad jump (r=-.27, p=.003) and the summarised physical test score (r=-.18, p=.045). This correlation was not evident among male students. In contrast, for male students, mass showed a positive correlation with the summarised physical test score (r=.20, p≤.001). Other gender disparities involved a positive correlation between body height and bench press performance for females (r=.18, p=.043), but not for males. Moreover, a negative correlation was discovered between age and rowing performance for males (r=-.14, p=.002), a correlation not detected in females.

Table 2. Correlations Both Genders

	Body Mass	Age	Pull-Ups	Broad Jump	Bench Press	Rowing	PFT Summarised	UFT Summarised
Body Height	.76a	.03	-.54a	.57a	.52a	.71a	.44a	.22a
Body Mass	1	.10a	-.60a	.48a	.72a	.75a	.47a	.20a
Age	.10a	1	-.18a	-.08b	.032	.013	-.13a	-.03

The table is based on Pearson correlation coefficient (r), and shows how body height, body mass, and age correlate with the physical fitness and use of force test scores for the genders merged.
N=645-655; a: p<.001; b: p<.05.

Table 3. Correlations Males

	Body Mass	Age	Pull-Ups	Broad Jump	Bench Press	Rowing	PFT Summarised	UFT Summarised
Body Height	.56a	-.09b	-.22a	.17a	0.00	.40a	.12a	.04
Body Mass	1	.02	-.32a	.015	.45a	.51a	.20a	.02
Age	.022	1	-.12a	-.21a	-.07	-.14a	-.22a	-.07

The table is based on Pearson correlation coefficient (r), and shows how body height, body mass, and age correlate with the physical fitness and use of force test scores for males.
N=521-530; a: p<.001; b: p<.05

Table 4. Correlations Females

	Body Mass	Age	Pull-Ups	Broad Jump	Bench Press	Rowing	PFT Summarised	UFT Summarised
Body Height	.47a	.12	-.28a	0.00	.18b	.34a	-.12	-.10
Body Mass	1	.14	-.38a	-.27a	.31a	.40a	-.18b	-.18
Age	.14	1	-.26a	-.30a	-.10	.030	-.24a	-.04

The table is based on Pearson correlation coefficient (r), and shows how body height, body mass, and age correlate with the physical fitness and use of force test scores for females.
N=124/125; a: p<.001; b: p<.05.

3.2.3 Multiple regression analyses

To explore the data more holistically, and to assess interrelationships between the variables, we conducted multiple regression analyses. We separated the genders and for each gender we created two regression models, one with the variable *PFT Summarised* as the dependent variable and one with the variable *UFT Summarised* as the dependent variable. Height, body mass and age were used as independent variables in both (all four) models.

The two models with the variable *UFT Summarised* did not meet the assumptions of normality. Although the normal P-P plots proved to be satisfactory (as well as tolerance and variance inflator factor (VIF) values and multicollinearity assessments), the scatterplots for these two models deviated somewhat from the desired rectangular distribution and took a somewhat clustered form. For this reason, we decided not to continue the analyses of these two models.

For the two models where the variable *PFT Summarised* functioned as the dependent variable, significant regression equations were found. For males, the equation was F (3, 519)=17.01, p<.001), with an R^2 of .09, meaning that the model explained 9% of the variance in the summarised physical test score. The model further showed that weight positively predicted (ß=.21, p<.001), and age negatively predicted (ß=-.22, p<.001), the outcome variable. For females the equation was F (3, 120)=3.43, p <.05), with an R^2 of .07, meaning that the model explained 7% of the variance in the summarised physical test score. The model further showed that age negatively predicted (ß=-.21, p<.05) the outcome variable.

3.2.4 One-way analysis of variance

As the correlation and regression analyses did not confirm our hypothesis of a gender difference in the association between students' body composition and age and their performance in UFT. Consequently, we decided to broaden our analyses. We categorised the UFT variable into three performance levels (low, medium, and high) and conducted a one-way analysis of variance (ANOVA), separating the genders. In these analyses, the *UFT Summarised* variable served as the independent variable, while body height, body mass, and age were the dependent variables. Our aim was to determine if there were average differences among the three performance categories in the UFT concerning body height, body mass, and age. We also sought to ascertain whether these variables were associated with the UFT performance in unique ways for each gender.

However, the only analysis yielding significant results among the categories was that female body mass was inversely related to performance in the UFT (F (2, 121)=3.20, p=.04). The effect size of the ANOVA, calculated by the eta squared, was .05 and interpreted as a small effect (Cohen, 1988). In the lowest performance group, the average body mass was 68.44 kg (SD=6.43), in the middle performance group, it was 66.99 kg (SD=7.39), and in the highest performance group, it was 64.30 kg (SD=4.55). Post-hoc comparisons (Table 5) using the Tukey HSD test indicated that the average difference (4.14 kg, 95% CI [0.25, 8.03]) between the lowest and the highest performance groups was significant (p=.03). Cohen's d was .69, which according to Cohen (1988), implies a moderate effect size.

Table 5. One-Way Analysis of Variance – Body Mass and UFT Performance for Females

UFT performance groups		Mean difference	Std. error	95% CI
Low	Medium	1.45	1.30	-1.63 – 4.53
	High	4.14b	1.64	.25 – 8.03
Medium	Low	-1.45	1.30	-4.53 – 1.63
	High	2.69	1.64	-1.21 – 6.59

The table shows the mean difference in body mass between three use of force performance (UFT) groups for females.
N=121; b: p<.05.

4. Discussion

To examine the relationships between police students' bodily characteristics and their performance on the PFT, as well as their capacity to handle the occupation-specific demands of physical exertion, this study scrutinised how the bodily characteristics of Danish police students (such as body height, body mass, age, and gender) influenced their performance on the PFT and their ability at a UFT. The significant findings of this study should have implications for the training of police students and officers in regard to performing the physically demanding tasks of policing satisfactorily.

4.1 The physical fitness test

4.1.1 Body composition, age, and gender

In the present study, when assessing data from both the correlation and regression analyses, it was observed that male police students with a larger body mass outperformed their lighter counterparts in the *PFT Summarised*. In contrast, and based on the correlational data, female police students with a larger body mass underperformed in the PFT compared to their lighter counterparts. Furthermore, our results suggest that taller male police students outperform their shorter counterparts in the Danish PFT. However, the regression analysis reveals this relationship to be somewhat spurious and that the confounding factor is body mass. For female police students, body height does not significantly affect the performance in the PFT. Age seems to have a negative impact on the performance of both male and female police students in the PFT. The findings of this study also indicate that male police students generally outperform their female counterparts in the PFT.

4.1.2 Pull-ups

Upon examining the individual elements of the PFT, we observed a negative correlation between body height and body mass, as well as age, and the performance of male and female police students in pull-ups. However, female students perform more pull-ups, albeit in a horizontal position, making the performance between males and females incomparable.

Pull-ups demonstrate a police student's ability to lift his or her own body. The negative correlation between pull-ups and body height and body mass might be due to taller police students having longer arms and the fact that body mass increases at a higher rate than the activated muscle forces (Harman, 2008, p. 79). Our results align with research by Sánchez-Moreno et al., where pull-ups showed a significant negative relationship with body mass (Sánchez-Moreno et al., 2016). Moreover, we observe that female police students are more affected by their body height compared to their male counterparts. This might be attributable to the lever principle, where taller female police students have to exert a larger amount of strength to lift themselves compared to their shorter colleagues.

In our study, age is negatively correlated with pull-ups. Research by Sörensen et al. (2000) explores the correlation between age and body mass among Finnish police officers. Their study reveals an increase in body mass and body fat over a fifteen-year research period. This rise in fat mass negatively impacts physical performance, particularly when measured by pull-ups (Sörensen et al., 2000, p. 5). Our findings align with research by Rezende et al. (2022), where Brazilian military police members participated in a five-year longitudinal study. The study reported a decline in pull-up repetitions by -0.11 per year. The greater body mass observed in older students in our study, potentially including higher fat mass than younger students, could account for the previously mentioned findings.

4.1.3 Broad jump

When examining the individual elements of the PFT, a positive correlation was observed between body height and body mass, and the broad jump for both genders combined. Among male police students, body height positively correlated with their performance in the broad jump. Conversely, in female police students, a larger body mass was associated with diminished performance in the broad jump.

Broad jump performance is associated with the maximum power output of the lower-body musculature (Krishnan et al., 2017, p. 142). The maximum power output is positively associated with body mass, as demonstrated by Nedeljkovic et al. (2009, p. 104). However, a study by Pierce et al. found a negative correlation between a higher body mass index (BMI) and broad jump performance in military personnel, potentially due to a disproportionate gain in body fat compared to muscle mass (Pierce et al., 2018, pp. 3, 17). Given that body mass was negatively correlated with broad jump performance for the female police students in the present study, the study by Pierce et al. could provide a possible explanation. This correlation between body mass and broad jump performance is also mentioned in numerous other studies (Boyce et al., 2008; Dawes et al., 2022a; Massuça et al., 2023). The broad jump is positively associated with body height for male police students, which might be due to a larger muscle mass and longer legs. However, research by Wu et al. (2003) shows opposite results, leaving the current research inconclusive.

Age exhibits a negative correlation with performance in the broad jump test, corroborating the research by Lockie et al. They examined the impact of age on the performance of police recruits prior to academy training, with a primary focus on the development of upper- and lower-body power. Their findings suggested that recruits aged 35 years and over demonstrated less power compared to their younger counterparts (Lockie et al., 2018b, p. 1974). These conclusions by Lockie et al. are consistent with the research by Izquierdo et al. (1999) in which an increase in age negatively influenced broad jump performance (Izquierdo et al., 1999, p. 262).

In the broad jump test, female students' performance does not match that of their male counterparts. This finding is in line with previous research and can be attributed to females generally being smaller and lighter than males, and possessing approximately 72% of their lower-body strength (Kraemer et al., 2001 p. 1012; Lockie et al., 2018b, p. 1771; Massuça et al., 2023). This is in agreement with earlier research by Pierce et al. Their study examined the differences in physical performance between U.S. Army trainees and discovered that female trainees performed at a distance 25% shorter than that of male trainees (Pierce et al., 2018, p. 17).

4.1.4 Bench press

Upon examining the individual elements of the PFT, we observed a positive correlation between body height, body mass, and bench press performance across both genders. Female police students demonstrated a positive correlation between body height, body mass, and bench press performance, whereas male police students only exhibited a positive correlation between body mass and bench press performance.

In the bench press, muscle force is exerted against an external object. As such, police students with a larger body composition may have an advantage over those with a smaller body composition. It could therefore be anticipated that bench press performance would increase with body height and body mass, assuming that some of the increase in body mass is due to muscle mass. Our findings align with previous research indicating that body height positively influences bench press performance (Falch et al., 2023; Ye et al., 2013, p. 409). This effect could be attributed to a larger body composition and, consequently, a greater muscle mass.

Previous research has identified a positive correlation between body mass, as well as lean body mass, and bench press performance (Dawes et al., 2016; Ferland et al., 2020, p. 285; Nedeljkovic et al., 2009, p. 104; Ye et al., 2013). This observation has been further supported by Reya et al. and Van Every et al. in their studies of powerlifters and resistance-trained men and women. Among other factors, lean body mass demonstrated a significant positive correlation with 1RM bench press performance (Reya et al., 2021, p. 2185; Van Every et al., 2022, p. 6).

In the current study, the bench press does not show any significant correlation with age. This lack of correlation may be attributed to the fact that the bench press is not negatively affected by body mass (Dawes et al., 2016).

Female police students performed at a lower upper-body absolute strength level than their male colleagues, as apparent in the bench press exercise. This could be due to males carrying more lean body mass, resulting in a surplus of upper-body strength when compared to women. Women display approximately 55% of the upper-body strength compared to men (Boyce et al., 2009, p. 2412; Kraemer et al., 2001 p. 1021; Rasteiro et al., 2023, p. 20).

4.1.5 2000-metre rowing on an ergometer

Previous studies have demonstrated that greater body height and body mass are beneficial when a subject's cardiovascular capacity is tested on a rowing ergometer (Akça, 2014, p. 136; Cosgrove et al., 1999). Our findings of a positive correlation between body height and body mass amongst police students when rowing a 2000-metre test on an ergometer align with these studies. This could potentially be due to factors such as larger muscle mass, longer arms, and longer legs, which could facilitate longer strokes (Akça, 2014, p. 136; Cosgrove et al., 1999, p. 848; Funch et al., 2021, p. 1395; Nedeljkovic et al., 2009, p. 104).

The performance of the male police students is negatively affected by age when rowing 2000 metres on an ergometer. This could be due to older male police students having poorer cardiorespiratory fitness, as also seen in a study by Dawes et al., where they investigated how physical test results for males and females were affected over a five-year period. They found decreasing physical test results among male officers but no significant differences among female officers (Dawes et al., 2022a).

Female students exhibited lower cardiovascular performance than their male counterparts. The male participants in our study, being taller and heavier than the female participants, had an advantage during the 2000-metre rowing test on an ergometer (Akça, 2014, p. 136; Funch et al., 2021, p. 1395; Nedeljkovic et al., 2009, p. 104). In a study by Lockie et al., law enforcement recruits undertook physical training on the first day of their programme. The results indicated that the performance of female recruits was more affected by the intensity of the cardiovascular training session than that of their male counterparts (Lockie et al., 2019b, p. 3). This is consistent with research from Knapik et al. and Krugly et al., where women exhibited a lower VO_2 max than their male colleagues (Knapik et al., 2001, p. 948; Krugly et al., 2022, p. 441).

4.2 Use-of-force and arrest simulation test

4.2.1 Body composition, age, and gender

In the present study, police students with larger body height and body mass outperformed their lighter and smaller counterparts in the UFT when the genders were analysed together. However, when categorised into three performance groups, we found the females in the highest performance group to have significantly lower-body mass compared to those in the lowest performance group. The difference between the two groups was found to have a moderate effect size. When analysing male and female police students separately, body height does not significantly affect their performance in the UFT. Regarding age, no significant differences were found. The findings of this study indicate that male police students outperform their female counterparts in the UFT.

4.2.2 Body composition

In relation to the UFT, the benefits observed in taller police students could be attributed to a larger muscle mass, an increased range of motion in the arms and legs during pushing and kicking actions, and an enhanced ability to control the subject's head, resulting in faster takedowns (Koropanovski et al., 2011, p. 112). When considering genders separately, a negative correlation between the UFT and female body mass becomes apparent. The lightest female police students may have an advantage in actions such as rising from the ground, changing direction, and executing swift physical actions – for instance, kicking or moving away from a charging perpetrator. However, a higher mass could be advantageous if it comprises muscle mass and/or if the police student is capable of utilising the additional body mass and strength when performing actions such as takedowns, punching, kicking, and pulling the perpetrator off balance (Loturco et al., 2016, p. 112; Suchomel et al., 2016).

This study demonstrates a negative correlation between the UFT and female body mass, aligning our results with research by Dawes et al. They found that officers classified as overweight might score lower on defensive tactics tests (Dawes et al., 2018, p. 325). In their study, police officers underwent a defensive tactics gauntlet, consisting of mandatory and previously trained self-defence techniques. The officers were categorised into two groups based on BMI: less than 25 (healthy) and more than 25 (overweight). Officers in the healthy group outperformed their overweight counterparts in the defensive tactics test and were less physically challenged (Dawes et al., 2018, p. 325). This disparity could be ascribed to the increased need for force production due to the inertia created by their larger fat mass. As a result, an individual with a higher body fat percentage must generate more force to effect a given change, such as a change in velocity or direction (Kukic et al., 2020a, p. 166; Norris et al., 2021, p. 625; Shepard et al., 2014, p. 11). Changes in velocity or direction, as well as rising from the ground, are actions often observed during the UFT, highlighting the importance of performing these actions swiftly.

Police trainees with a lower mass may face greater relative resistance when conducting use-of-force exercises, body drag tasks, simulated arrest situations, or pursuits while wearing a uniform. This resistance is further increased by the additional load of items such as personal protection vests (Kukic et al., 2020b, p. 733). Our study aligns with the observation by Kukic et al., suggesting that a larger body mass does not necessarily hinder performance in a PFT or UFT, provided the increased body mass is due to a larger lean body mass, rather than excess body fat. This is consistent with research by Lockie et al. (2021, p. 1292), Ras et al. (2024), and Acevedo et al. (2024), which underscores the importance of a higher percentage of skeletal muscle mass for superior test performances.

The above could lead to the conclusion that body mass, particularly muscularity, is of paramount importance for the performance of police trainees when tested in use-of-force and simulated arrest situations. However, we must consider a study by Kukic et al. that investigated the physical abilities of police officers with muscular, very muscular, and highly muscular body compositions. The study concluded that physical performance might be negatively impacted once the BMI exceeds 27.5 kg/m^2 (Kukic et al., 2018, p. 35). Thus, a ceiling effect may need to be considered, which warrants further detailed study in the future. The necessity of scrutinising individual elements of physical and occupational tests, as well as the subjects used, is evident.

4.2.3 Age

The lack of a negative correlation between age and the results of the UFT could be attributed to multiple factors. Increased age may correspond to a larger body mass, potentially improving performance during force application tests. Concurrently, the students may not yet have reached an age where they have accumulated excessive fat, which could hinder their movement and ability to utilise force and force techniques. It is widely acknowledged that the ageing process impacts human musculature. Muscular power, particularly in groups aged over 40, diminishes, ostensibly due to a decrease in muscle mass. This reduction is attributed to changes in daily physical activity, leisure time physical activity, and shifts in hormonal balance (Dopsaj et al., 2020; Fleck & Kraemer, 2004, p. 304; Kukic et al., 2020c; Lagestad & van den Tillaar, 2014b, p. 79; Teixeira et al., 2019, p. 166).

Dawes et al. investigated the impact of age on highway patrol officers, finding that physical strength, muscular endurance, and cardiorespiratory fitness declined with age (Dawes et al., 2017). Similarly, Marins et al. (2021) explored the correlation between age and selected physical fitness measures, concluding that increased age resulted in a decline in muscular endurance, strength, lower-body power, and cardiorespiratory fitness among federal highway patrol officers. Araujo et al. (2020, p. 283) also observed age-related declines in power, strength endurance, and cardiorespiratory fitness among elite police agents in Portugal (Araujo et al., 2020, p. 283).

These results may be attributed to the age and activity-related changes mentioned previously, further substantiated by research conducted by Sörensen et al. Their study observed an increase in body mass and waist-to-hip ratio over a 15-year period among Finnish police officers (Sörensen et al., 2000, p. 5). Consequently, our study's findings only partially align with previous research, which emphasises that higher age reduces police officers' performance in both physical and occupational tests (Araujo et al., 2020, p. 284; Beck et al., 2015, p. 2340; Dawes et al., 2022b, p. 3; Marins et al., 2018b, p. 428; Teixeira et al., 2019, p. 166; Vianna et al., 2007, p. 1311).

4.2.4 Gender

Male police students outperform their female counterparts in the UFT. Being taller and heavier is particularly advantageous for male students. This may be attributed to male students possessing greater muscle mass, superior body height, and a broader range of arm and leg movements when pushing and kicking. A larger body composition also provides better control over the subject's head, facilitating quicker takedowns, among other benefits (Koropanovski et al., 2011, p. 112). Our findings are consistent with research conducted by Lockie et al., who examined the impact of gender on the performance of police recruits. Their findings suggested that women were less proficient than men in terms of upper- and lower-body power (Lockie et al., 2018b, p. 1771).

Moreover, a study by Marins et al., which included tests of male and female Brazilian federal highway patrol officers, indicated that male police officers exhibited greater upper-limb muscular endurance and aerobic capacity (Marins et al., 2021). This could cause women to work at a higher relative intensity when performing tasks such as arrest situations. These results align with previous research, suggesting that, due to physiological differences between men and women, women often perform at a lower physical level than their male colleagues in PFTs and occupational physical tests (Barnekow-Bergkvist et al., 2004, p. 1241; Dillern et al., 2014b, p. 198; Fleck & Kraemer, 2004, p. 264; Lockie et al., 2020, p. 938; Shephard & Bonneau, 2002, p. 265; Taylor et al., 2012, p. 2913; Wilmore & Davis, 1979, p. 37).

Women generally perform at a lower level than men when the task requires moving a set load, such as in a body drag where absolute strength is tested (Lockie et al., 2019a, p. 161, 2022, p. 575). This discrepancy could be attributed to differences in body composition, including body height and body mass (Lockie et al., 2021, p. 1292). The female police students in this study were shorter and lighter than their male counterparts. Consequently, these female police students face larger relative resistance when conducting use of force, simulating arrest situations, or pursuing while in uniform. This can be exacerbated by the additional load of items such as personal protective vests (Kukic et al., 2020b, p. 733).

However, it is noteworthy that following a 24-week exercise training programme, the highest-performing females might be capable of outperforming some of their male colleagues in various physical tests, such as sit-ups or a specific work test battery (Kraemer et al., 2001, p. 1023; Lockie et al., 2020, p. 937).

These results bear significant implications for both police students and incumbent officers. Considering that female officers may be operating or training at a relatively higher intensity for the same exercise compared to male officers, their risk of injury could potentially increase. This factor should be taken into account when conducting classes (Knapik et al., 2001, p. 950).

5. Limitations

The present study has limitations that are vital to acknowledge for a comprehensive understanding of the results. In our endeavour to create a use-of-force test simulating a genuine, real-life operational scenario, factors such as environmental and physical considerations were paramount. Constraints included the use of a training facility with a lower risk of injury, students wearing attire uncharacteristic of active duty uniforms, and the potential for cumulative exhaustion from successive test scenarios. These elements differed from the uncontrolled situations that police trainees might encounter in their professional careers.

Moreover, the inherent complexity associated with a use-of-force and arrest simulation test necessitates that assessors possess extensive experience and a profound understanding of the criteria governing their performance assessment. Despite our dedication to ensuring inter-rater reliability through the employment of experienced assessors, the reliability was not examined in this study. To counterbalance individual assessor bias, we utilised three assessors concurrently to mitigate potential discrepancies in the test assessment influenced by single assessor preferences. The assessment did not explore the influence of factors such as the participant's prior or extracurricular martial arts/self-defence training. These variables could potentially affect the skill level of the students and, consequently, their performance during the test. Furthermore, test participants were asked to match the level of force, aggression, and speed to that of their adversaries, ensuring safety but possibly limiting the replication of realistic, uncontrolled situations.

Substantial differences in body height, body mass, and strength, as well as gender, were examined in relation to the application of use-of-force techniques, but the inclusion of measurements like skinfold thickness, fat-free mass, and fat mass could have enriched the study data. Lastly, we encountered challenges in discerning gender-based variances in measurements due to the non-comparable nature of the pull-up test procedures between genders. These specific divergences suggest potential constraints when drawing gender-specific conclusions.

In summary, while our current study design provides valuable insight, it exhibits limitations in terms of fully replicating real-world fidelity and comprehensively determining the factors impacting the application and effectiveness of use-of-force techniques.

6. Conclusion and Practical Recommendations

The findings of this study offer valuable insights into the relationship between bodily characteristics, including body composition, age, and gender, and the performance of Danish police students in both the PFT and UFT. Overall, the findings suggest that PFT and UFT performance is influenced by a complex interplay of body composition, age, and gender, with some measures showing positive correlations and others negative. These findings underline the importance of incorporating these factors into the design of training programmes and the assessment of police students' physical and operational capabilities.

6.1 Body Composition

The study identified significant roles of body mass and height in the performance of police students in both PFT and UFT. Specifically, male police students with larger body mass and height generally outperformed their lighter and shorter counterparts in PFT; however, this was not apparent in the UFT, indicating that physical size alone does not predict operational effectiveness advantage. Female police students with larger body mass underperformed in comparison to their lighter peers in both tests.

Actionable recommendations in relation to body composition:

- Implement evidence-based individualised strength and conditioning programmes with a focus on improving lean muscle mass and enhancing overall performance.

6.2 Age

Age negatively impacted the performance of both male and female police students in the PFT, notably in pull-ups and broad jump tests, yet showed no significant effect on UFT performance.

Actionable recommendations in relation to age:

- Customise age-specific programmes and address the specific physical challenges associated with ageing, with a focus on maintaining fitness levels throughout the career.

6.3 Gender

Male police students typically outperformed their female counterparts in both PFT and UFT, a disparity that can be attributed to inherent physiological differences, such as body composition and muscle mass.

Actionable recommendations in relation to gender:

- Develop gender-specific training to take physiological differences into account, providing additional support to help female students overcome gender-related challenges.
- Due to the inherent physiological differences training should be expanded to include training with focus on tactical, psychological, and decision-making skills that complement physical preparedness.

6.4 General actionable recommendations

- Further investigation into work demands specific to the many different tasks that police officers may encounter on a daily basis is needed in order to construct PFTs that are reliable test tools.
- Conduct continuous fitness assessments to regularly monitor physical capabilities and adjust training programmes based on updated data and evaluations.
- Incorporate feedback mechanisms such as ongoing evaluations to refine training protocols and criteria.
- Collaborate with other research institutions to stay informed about the latest scientific findings related to law enforcement fitness and performance, continually updating training programmes accordingly.

By integrating these recommendations, police organisations can better prepare their personnel for the physically and operationally demanding tasks they may encounter, ultimately enhancing their performance and potentially reducing the risk of injury.

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