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Lockie, Robert; Dawes, J. Jay; Orr, Rob Marc

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Health and Fitness Data for Police Officers within a Health and Wellness Program: Implications for Occupational Performance and Career Longevity

Brief Running Head: Police Officer Fitness and Wellness Programs

Key words: blood pressure; law enforcement; muscular endurance; strength; tactical

Abstract

BACKGROUND: Health and wellness programs can be implemented at police departments. Little research has detailed the characteristics of officers within these programs.

OBJECTIVE: To analyse the health and fitness data of officers involved in a health and wellness program from 2018-2020, and to profile the officers involved relative to population norms.

METHODS: Analysis was conducted on archival data from 633 officers (523 males, 110 females) who participated in a health and wellness program from a large city police department. Data included: body mass; body fat percentage; blood pressure (BP); estimated maximal aerobic capacity; sit-and-reach; push-ups; vertical jump; grip strength; sit-ups; bench press ratio. Data were grouped by year (2018, 2019, 2020), and a univariate ANCOVA with Bonferroni post hoc adjustment determined any significant between-group differences. Individual officer data were also compared to population norms.

RESULTS: The 2020 group had higher systolic BP compared to both other groups, and superior sit-and-reach and grip strength compared to the 2018 group ($p<0.05$). Compared to population norms across the 3 years, 74-86% of officers had BP elevated above normal levels. Depending on the fitness component measured most officers (69-98%) were categorised as average or better.

CONCLUSIONS: There were few differences between the year groups, although the 2020 officers did have superior sit-and-reach and grip strength. The higher systolic BP from the 2020 group may be indicative of the challenges of the year (pandemic, civil unrest). Officers generally had good profiles relative to population norms. The wellness program appeared to benefit the well-being of officers.

1. Introduction

Police officers experience unique demands within their occupation. Some physically challenging tasks that need to be completed by officers include driving a vehicle at high speeds [1, 2], pursuing suspects [3-7], clearing obstacles [3-8], discharging firearms, and exerting force to apprehend offenders [9]. Fitness could positively impact an officer's ability to successfully perform these physically challenging job tasks [3, 6, 8, 10-12]. For example, Dawes et al. [8] found large-to-very large correlations ($p < 0.001$, $r = -0.52$ to -0.70) between aerobic fitness (measured by the 20-m multistage fitness test), upper-body and abdominal muscular endurance (measured by push-ups and sit-ups performed in 60 s, respectively), and lower-body power (measured by the vertical jump) with time to complete a physical ability test among state patrol officers. Dawes et al. [8] also found isometric lower-body and grip strength had small correlations ($p < 0.05$, $r = -0.10$ to -0.14) with the physical ability test. The physical ability test incorporated tasks such as a foot pursuit, lifting, carrying, pushing, crawling, and dragging tasks, obstacle clearance, and walking on uneven terrain [8].

While policing can be physically demanding, most of a police officer's shift will typically feature low-intensity activity (e.g. sitting in a vehicle, office work) [13]. Accordingly, previous research has indicated that the nature of policing may negatively impact an officer's health and fitness [13, 14], in part due to reduced physical activity. To provide an example of the decrease in fitness experienced by incumbent officers, Orr et al. [14] compared state patrol officers to cadets undergoing academy training. Orr et al. [14] found that age-matched male patrol officers displayed poorer muscular endurance (fewer push-up and sit-up repetition completed in 60 s), anaerobic endurance (slower 300-m run time), and aerobic fitness (slower 2.4-km run time). Female officers had lesser upper-body maximal strength (lower one-repetition maximum [1RM] bench press) and endurance (fewer push-up repetitions in 60 s) [14]. Furthermore, as officers age during their service there may be some age-related declines in fitness [15, 16], which may negatively impact their ability to complete job tasks and potentially lead to performance decrements for officers.

A police officer's decrease in health and fitness may be affected by a variety of factors additional to reduced physical activity. Some of these factors include stress, shift work, decreased sleep time, and poor dietary choices [13, 14, 17]. The cumulative effect of these variables can increase the risk of cardiovascular disease in officers [17]. As a result, it is important to not only track the fitness of police officers, but other health-related indicators as well (e.g. blood pressure [BP], body composition). Indeed, the documentation of blood pressure and body composition has been recommended in law enforcement populations [18]. There has been limited specific analysis, however, of the health characteristics of incumbent police officers. Moreover, there has been minimal investigation regarding the impacts that certain strategies could have in reducing the decrements in health and fitness experienced by police officers. One such strategy is the utilisation of health and wellness programs.

Health and wellness programs for police officers often focus on different issues affecting personnel. These can include cardiovascular fitness, chronic disease prevention, alcohol and drug use interventions, nutritional choices, body weight management, musculoskeletal conditioning, injury prevention, safe driving, stress management, and resilience to trauma [19, 20]. Depending on the intended outcome, the program could involve fitness testing, exercise programs (either supervised or provided to officers to complete on their own time), and education about factors such as exercise and nutrition [20]. These programs are typically voluntary, although incentives may be incorporated as part of program participation. For example, attaining certain standards within fitness testing could result in some form of reward for the officer (e.g. financial incentives) [19].

The potential positive benefits of these programs have been previously described [19, 20]. For example, officers involved in wellness programs tend to participate more in physical activity [19], and accordingly can also demonstrate better fitness outcomes. Kuhns et al. [19] reported that for one law enforcement agency in the USA, 81% of officers involved in a wellness program passed an agency-specific fitness test (specific details of the fitness testing were not provided). Furthermore, participation in health and wellness programs may reduce the mental distress experienced by officers as a result of their occupation [20]. A limitation of health and wellness programs administered by police departments is that officers who could benefit from these programs may not participate as they are generally voluntary. Nevertheless, it would be of benefit to provide a profile of the health and fitness of officers who are involved with wellness programs. Further research has been recommended in this area as there are gaps in the literature detailing the health and fitness of incumbent officers [19]. It would be of great benefit for a study to investigate the health and fitness of police officers from year-to-year within a health and fitness program. Further, a study that demonstrates the health and fitness of officers relative to the general population would demonstrate whether the officers are at least apparently healthy. This would be of great benefit considering the physical [3, 6, 8, 10-12] and mental [20] demands associated with policing. The current study would fill this research gap and contribute to the science system by providing impactful information for police departments worldwide. This study may provide evidence related to the value of health and wellness programs for police department command staff, and potentially motivate those officers not involved in these programs to become involved.

Therefore, this study involved a retrospective analysis of archival data that were collected by a large city police department as part of their health and wellness program. The department provided de-identified data from police officers who participated in a health and wellness program from 2018-2020. The purpose of this study was not to track individual officers across the three years but rather to analyse the police officers as a group to firstly identify whether general involvement in the health and wellness program either maintained or improved the collective health and fitness of officers. The second purpose of the study was to profile the health and fitness of officers involved in the program relative to general population norms [21-23]. It was hypothesised that there would be no significant differences between the health and fitness tests across the three years and officer cohorts would maintain their level of health and fitness. It was further hypothesised that due to program participation, the officers from this sample would have good health and fitness characteristics relative to normative data.

2. Methods

2.1. Participants

Retrospective analysis of a convenience sample of officer health and fitness data from three years belonging to one large city police department was conducted. This sample comprised 633 officer data sets across the three years. This included 170 males (age: 40.44 ± 8.05 years; body mass: 90.56 ± 15.46 kg) and 39 females (age: 35.28 ± 9.19 years; body mass: 69.45 ± 14.14 kg) in 2018; 194 males (age: 39.63 ± 8.43 years; body mass: 89.08 ± 13.08 kg) and 44 females (age: 35.16 ± 8.82 years; body mass: 71.59 ± 13.10 kg) in 2019; and 159 males (age: 41.28 ± 7.77 years; body mass: 88.96 ± 13.40 kg) and 27 females (age: 37.70 ± 7.42 years; body mass: 69.10 ± 13.21 kg) in 2020. Height data were not provided by the agency to the researchers, but this has occurred in previous law enforcement research [24, 25]. As this study involved the retrospective analysis of archival police officer data sets from a health and wellness program, the researchers did not control the number of officers that participated in the program. Nonetheless, the inclusion criteria for this study was all officers that were available within the data sets were included in the. The exclusion criterion was data sets with clearly incorrectly entered data. As secondary data was utilised in this study, G*Power software (v3.1.9.2, Universität Kiel, Germany) was used to confirm post hoc that the sample size of 633 was sufficient for an analysis of covariance (ANCOVA) such that data could be interpreted with a small effect level of 0.15 [26], and a power level of 0.9 when the alpha level was set at 0.05 [27]. Based on the retrospective nature of this analysis, the institutional ethics committee approved the use of pre-existing data (HSR-17-18-370). The study was conducted according to the Declaration of Helsinki [28].

2.2. Procedures

The officers volunteered to be part of the health and wellness program, although they did receive financial incentives if they reached certain milestones as part of the fitness testing. All fitness testing was conducted on-site at the department by an outsourced wellness provider. The wellness provider's staff were all trained in the required procedures for each test, and the officers were scheduled when available. Fitness testing was on-going throughout the calendar year, and at numerous times during the day (approximately from 8:00am to 5:00pm), depending on officer availability. Officers who were within the program could be coming in from the field, on an off day, or before or after shift. Although this type of scheduling could have affected some of the data that were recorded, this was unavoidable given the numerous scheduling conflicts that occur for a police officer (e.g., shift work, long hours, overtime, court appearances, family and personal commitments, etc.) [29, 30]. It should be noted however that these scheduling conflicts represent real-world challenges typical to these programs. As such, provide pragmatic research that is a true representation of outcomes from these programs. Furthermore, health and fitness testing also occurred in 2020, and some of these tests were affected by the pandemic and the mandated requirements of this time (e.g., social distancing) [31, 32].

Officers began procedures in an office setting by completing the requisite departmental release forms. They then completed the health and fitness tests in the order presented, unless there was a certain test that the officer did not complete due to some form of physical limitation (e.g., pre-existing injury). The health and fitness tests took approximately 60 minutes to complete.

2.3. Height, Body Mass, and Body Fat Percentage (BF%)

Officers had their height, body mass, and body fat percentage (BF%) measured first. The height data were not included in the data set provided to the researchers and, as such, was not included in this study. Body mass and BF% were recorded by a bioelectrical impedance analysis (BIA) device (Tanita Corporation, Tokyo, Japan). Previous police research has utilised BIA in body composition analyses [33]. Protocol guidelines provided by the manufacturer were used to record body mass via BIA [33, 34]. The device used foot-to-foot measures, and the officer stood barefoot on the footplates. The officer's age, height in inches, and sex were entered into the device. Proprietary equations were used within the device to calculate BF%. Staff recorded the variables of interest displayed on the device.

2.4. Blood Pressure (BP)

Blood pressure (BP) was measured manually in 2018-2019, and electronically in 2020 to adhere to social distancing guidelines [32]. This metric was recorded after the officers were seated quietly for several minutes, and systolic and diastolic BP were measured and recorded in millilitres of mercury (mmHg). In all years of data collection, officers were first seated with their feet flat on the floor and their left arm in a supported, relaxed position at heart level. Clothing was removed or repositioned such that the cuff was placed on bare skin without any compression above the cuff. The cuff position was above the crease of the elbow and encircled approximately 75-100% of the arm [35]. In 2018-2019, staff then followed the standard procedures required for manually measuring blood pressure [36]. In 2020, BP was measured with an automated device (Omron Healthcare, Kyoto, Japan). Although there are limitations in comparing BP measured in two different ways, this was unavoidable due to COVID-19. Nonetheless, electronic BP measurement has been recommended for use in law enforcement populations [18]. Once the cuff was affixed on the officer's arm, staff followed the directions presented on the automated device.

2.5. Estimated Maximal Aerobic Capacity ($\dot{V}O_{2max}$)

The officers had their estimated maximal aerobic capacity ($\dot{V}O_{2max}$) measured via the Gerkin protocol (submaximal testing) on a treadmill. This protocol has been used previously among other first responders (e.g., firefighters) [37-40], and has application to police officers. Heart rate during the test was monitored by the health and wellness program staff via 12-lead electrocardiogram. As described in the literature [37, 39], the test began with a warm-up period of 3 minutes at a speed of 3.0 miles per hour (mph; 4.83 km per hour). After the warm-up, the treadmill speed was increased to 4.5 mph (7.2 km per hour). The speed (0.5 mph, or 0.8 km per hour) and grade (2%) were then alternately increased every 60 s until the officer achieved a heart rate greater than 85% of their age-predicted maximum heart rate. Each 60-s stage consisted of four intervals of 15 s, and time to 85% of age-predicted maximum heart rate was recorded as the 15-second interval before actual achievement of this heart rate. An example, described by Tierney et al. [39], intimated that an officer who achieved 85% of their age-predicted maximum heart rate at

10:20 was recorded as 10.25 minutes, an officer who reached 85% of % of age-predicted maximum heart rate at 10:30 was recorded as 10.5 minutes. The time was then applied to a prediction equation to calculate estimated $\dot{V}O_{2max}$ [37-40]. Estimated maximal aerobic capacity ($\dot{V}O_{2max}$) was recorded in millilitres per kilogram per minute ($ml \cdot kg^{-1} \cdot min^{-1}$). In 2020, a much smaller sample of officers completed this test. This was because the treadmill test was removed from the testing protocol due to social distancing guidelines. Nevertheless, what data was available from this year was included in the analysis.

2.6. Sit-and-Reach

The sit-and-reach measured hamstring flexibility [41], and used procedures detailed in the literature [16]. Officers removed their shoes and sat with both feet flat against the sit-and-reach box (Novel Products, Inc., Rockton, USA) and positioned their hands one on top of each other (tips of the middle fingers aligned), with the palms down. The officer then flexed at the hip forward slowly and reached as far along the scale as possible. The knees remained extended throughout the reach and the officer held this position for 5 s. Three trials were performed, with the furthest reach distance measured in cm used for analysis.

2.7. Push-ups

Upper-body muscular endurance was assessed via a maximal push-up test where the officer completed as many repetitions as possible [22]. A block with a diameter of approximately 6 centimetres (cm), or 2.5 inches, was placed under the chest of the officer to ensure they descended to the correct depth [42, 43]. On the start command, the officer flexed their elbows and lowered themselves until their chests contacted the block before they extended their elbows to return to the start position. Officers performed as many push-ups in a consecutive manner until failure or a pause was identified in the push-up cadence, with the recorded result being the number of correctly completed repetitions.

2.8. Vertical Jump

A Vertec apparatus (Perform Better, Rhode Island, USA) was used to measure vertical jump height, and followed established assessment protocols [6, 33, 44-46]. The officer initially stood side-on to the Vertec (on the officer's dominant side), reached upward as high as possible and displaced as many vanes as possible while keeping their heels on the floor. The last vane moved became the zero reference. The officer then jumped as high as possible with no preparatory step or restrictions placed on countermovement range of motion, and height was recorded from highest vane moved. Vertical jump height was calculated in inches by subtracting the standing reach height from the jump height, and measurements were recorded in inches (before being converted to cm for the data analysis). Officers completed three trials, with the best trial used.

2.9. Grip Strength

Upper-body strength was measured by a hand grip dynamometer (Takei Scientific Instruments, Japan) [47]. Officers kept their testing arm by their side when standing throughout the assessment and squeezed the handle as hard as possible for approximately 2-3 s, which was monitored by the tester [10, 15, 33, 46]. Two attempts were completed for each hand and recorded to the nearest kg [10, 33, 46]. The best score for each hand was summed to provide the combined grip strength score.

2.10. Sit-ups

Abdominal muscular endurance was assessed via the sit-up test, where officers completed as many repetitions as possible in 60 s. The technique used for the sit-up assessment was typical for law enforcement populations [8, 14, 16, 43, 48, 49]. The officers laid on their backs with their knees flexed to 90°, heels flat on the ground, and hands cupped behind their ears. The feet were held to the ground by a partner during the test. On the start command, officers raised their shoulders from the ground while keeping their hands cupped at their ears and touched their elbows to their knees. The officer then descended back down until their shoulder blades contacted the ground. Officers completed as many repetitions as possible in 60 s, with the recorded result being the number of correctly completed repetitions. Within the health and wellness program, officers had the option of completing a plank rather than sit-ups if they had pre-existing lower back issues. However, these data were not included in this study.

2.11. Bench Press

Bench press ratio was calculated from the 1RM bench press, and testing procedures followed established protocols [50]. An Olympic bar and weight plates on a Smith machine system was used. The officer laid on a flat bench with their feet flat on the floor, and their head, shoulders, and buttocks flat to the bench. Officers selected their 'strongest position' and used a pronated grip. The officer un-racked the bar with assistance from a staff member acting as a spotter as needed and began the lift with the arms extended. The 'touch-and-go' procedure was utilised, in that the bar was required to touch the chest, pause briefly, before being pressed to full arm extension. Officers were also given the option to pause at 90° elbow flexion to provide protection to the shoulder joint. A repetition was successful when the bar was moved from the chest to a position of full elbow extension. Failure to do this, or allowing the bar to rebound off the chest, disqualified a repetition. The staff member/spotter did not touch the bar except in the event of a failed lift. Officers initially were advised to start with a warm-up weight at approximately 60-75% of their estimated 1RM for warm-up repetitions followed by 3-5 repetitions at 85% of the estimated 1RM, with 2 minutes recovery between sets. Officers then completed their first 1RM attempt. If the officer was successful, loads increased by approximately 2.5 kg until failure. Generally, no more than five attempts were needed before the 1RM was reached, with 3 minutes rest provided between attempts. Bench press ratio was scaled relative to body mass via the formula: $1RM \cdot body\ mass^{-1}$. This variable was used for analysis.

2.12. Statistical Analyses

Statistical analyses were processed using the Statistics Package for Social Sciences (Version 27; IBM Corporation, New York, USA). Descriptive statistics (mean ± standard deviation [SD]) were calculated for each variable. Not all officers completed all tests (e.g., officers with low back issues did not complete the sit-up test); however, all available data sets were included in the analysis. The sample was divided into three groups based on which year data was collected: 2018, 2019, or 2020. Levene's test for equality of variances assessed the homogeneity of variance of the data, with significance set at $p < 0.05$. If data were found to be heterogeneous, the alpha level required for between-group significant interactions was adjusted to $p < 0.01$ to reduce Type I errors [4]. A univariate ANCOVA was used to determine whether there were significant differences between the groups. Within the year groups, the sexes were combined [16, 46]. Nevertheless, sex was used as a covariate as previous research has illustrated between-sex differences in the physical performance of law enforcement personnel [15, 42, 43]. All variables except for age and height were also independently analysed with age as an additional covariate [4, 11], as age can influence body mass and fitness test performance [14-16, 42, 44]. If a significant interaction between the groups was found, a Bonferroni post hoc adjustment for multiple pairwise comparisons was adopted ($p < 0.05$).

Individual data were then compared to categorical normative data, relative to sex and age. Blood pressure classifications were drawn from standards detailed by Pescatello et al. [21]. Estimated $\dot{V}O_{2max}$, sit-and-reach, push-ups, grip strength, and bench press ratio were compared to normative data presented by Riebe et al. [22]. BF% and sit-ups were compared to normative data depicted by Ryan and Cramer [23]. The variables were then profiled using Microsoft Excel (Microsoft Corporation^{TM}, Redmond, Washington, USA). Male and female officers were grouped together according to the respective categories for the different measures, as sex-specific standards were provided [21-23]. Even so, the number of male and female officers per category was noted.

3. Results

Mean data recorded from officers in each year in the health and fitness program is shown in Table 1. Homogenous data was indicated for age ($F_2 = 1.271$, $p = 281$), body mass ($F_2 = 0.833$, $p = 0.435$), BF% ($F_2 = 1.424$, $p = 0.241$), estimated $\dot{V}O_{2max}$ ($F_2 = 0.015$, $p = 0.985$), sit-and-reach ($F_2 = 1.206$, $p = 0.300$), push-ups ($F_2 = 0.139$, $p = 0.870$), vertical jump height ($F_2 = 1.718$, $p = 0.180$), combined grip strength ($F_2 = 0.324$, $p = 0.724$), and sit-ups ($F_2 = 0.395$, $p = 0.674$). The alpha level for significance for these data was set to $p < 0.05$. Heterogeneous data were indicated for systolic BP ($F_2 = 12.668$, $p < 0.001$), diastolic BP ($F_2 = 19.626$, $p < 0.001$), and the bench press ratio ($F_2 = 20.689$, $p < 0.001$) The level for significance for these data was set to $p < 0.01$.

INSERT TABLE 1 ABOUT HERE

There was a significant interaction for systolic BP ($F_2 = 51.503$, $p < 0.001$), sit-and-reach ($F_2 = 3.891$, $p = 0.021$), vertical jump ($F_2 = 3.261$, $p = 0.039$), and combined grip strength ($F_2 = 7.967$, $p < 0.001$). The 2020 group had a significantly higher systolic BP than the 2018 and 2019 groups ($p < 0.001$). The 2020 group had a significantly further sit-and-reach distance compared to the 2018 group ($p = 0.036$). This group also had a further sit-and-reach compared to the 2019 group, but the difference did not reach significance ($p = 0.052$). This was also the case for the vertical jump, where the pairwise comparisons did not reach significance ($p = 0.072$-1.000). The 2020 group did have a significantly greater combined grip strength compared to the 2018 group ($p < 0.001$), but not the 2019 group ($p = 0.086$). There were no significant between-group interactions for age ($F_2 = 2.451$, $p = 0.087$), body mass ($F_2 = 0.624$, $p = 0.536$), BF% ($F_2 = 0.807$, $p = 0.446$), estimated $\dot{V}O_{2max}$ ($F_2 = 1.256$, $p = 0.286$), push-ups ($F_2 = 2.608$, $p = 0.074$), sit-ups ($F_2 = 1.959$, $p = 0.142$), and the bench press ratio ($F_2 = 0.357$, $p = 0.700$). Diastolic BP did not have a significant interaction ($F_2 = 3.276$ $p = 0.038$) due to the more stringent alpha level requirement of $p < 0.01$.

Health and fitness assessments for the officers, relative to normative data in each of the 3 years of data collection, is shown in Figures 1-8. For BF% (Figure 1), in 2018 61% of the sample were average-to-very lean (117 males, 10 females). This number was 63% in 2019 (139 males, 8 females), and 68% in 2020 (119 males, 7 females). However, there were a relatively higher number of females within the program classified as overfat (2018 = 17 or 17% of the females; 2019 = 22 or 51% of the females; 2020 = 10 or 14% of the females). With regards to BP (Figure 2), in 2018 approximately 74% of the sample (130 males, 18 females) were classified as elevated-to-Stage 2 hypertension. This number rose to 78% (160 males, 25 females) in 2019, and 86% (141 males, 19 females) in 2020. When considering estimated $\dot{V}O_{2max}$ (Figure 3), 95% of the sample (160 males, 38 females) in 2018 were considered good-to-superior. In 2019 this was 93% (169 males, 42 females) of the sample. In 2020 there was data for only 10 officers (9 males; 1 female); all were considered good-to-superior in estimated $\dot{V}O_{2max}$.

INSERT FIGURES 1-8 ABOUT HERE

Regarding the sit-and-reach (Figure 4), 69% of officers (117 males, 27 females) were rated as good-to-excellent in 2018. This number rose to 73% in 2019 (140 males, 33 females), and 80% in 2020 (124 males, 24 females). Push-ups, shown in Figure 5, had 98% of officers graded as good-to-excellent in 2018 (168 males, 35 females), 2019 (190 males, 40 females), and 2020 (159 males, 18 females). Concerning grip strength (Figure 6), in 2018 69% of the officers (118 males, 25 females) were classed as good-to-excellent. In 2019, that number rose to 79% (147 males, 30 females), and in 2020, the number rose again to 83% (134 males, 19 females). For sit-ups (Figure 7), 83% of the sample (123 males, 28 females) in 2018 were rated as average or above average. The number was 86% in 2019 (138 males, 26 females), and 85% in 2020 (115 males, 16 females). In 2018 and 2019, no officer was categorised as well above average in sit-ups. In 2020, one female officer was rated as well above average. For the bench press ratio in 2018 (Figure 8), 88% of the sample (149 males, 34 females) were classified as good-to-superior. This number was 89% in 2019 (174 males, 35 females), and 92% in 2020 (148 males, 20 females).

4. Discussion

This study analysed archival health and fitness data recorded as part of a health and wellness program for a large city police department. Despite general recommendations that officers should participate in these types of programs [19, 20], there has been little investigation as to the characteristics of officers that do participate. There were two goals for this study; firstly, to analyse the officers as a group across 3 years (2018, 2019, and 2020) to ascertain whether involvement in the health and wellness program maintained or improved health and fitness of a cohort of participating police officers. The second goal was to profile the officers relative to normative data from the general population [21-23]. It was hypothesised that there would be no significant differences between the health and fitness test data across the three years, and that officers from this sample would have good health and fitness characteristics compared to the general population. These hypotheses were shown to be partially supported. The 2020 group had significantly greater systolic BP, grip strength, and sit-and-reach. Additionally, a high number of the officers in each year had positive profiles in the different health and fitness variables. The results from this study have important implications for police departments that use (or wish to implement) health and wellness programs.

The data generally showed few significant changes over the 3 years of data collection within the program. This can be viewed as a positive result, especially for officers involved with the program for multiple years. Fitness generally declines with advanced age [15, 16]. If participation in a health and wellness program retards this process, this would be beneficial for individual officers and the department as a whole. Additionally, there were some extra noteworthy findings with regards to the fitness variables. Sit-and-reach distance, which provided a measure of hamstring flexibility [41], was significantly greater in the officers tested in 2020. Specific to policing job tasks, flexibility is important for conducting searches (e.g., in cells, vehicles, rooms in houses) [51, 52], and for manual handling [53]. Hamstring flexibility has also been found to decrease overuse injuries in military trainees [54], so this could also influence injury occurrence in police officers. Police officers typically sit a lot during a work shift (e.g., in a vehicle or office) [13], and this could negatively impact flexibility [55]. The completion of specific exercises through a full range of motion at least 2 times per week has been recommended for improving flexibility [56]. It is possible that officers within the health and wellness program were able to do this, and this was also supported by the comparisons to normative data. Across the 3 years, 69-80% of officers were graded as having good-to-excellent flexibility as measured by the sit-and-reach [22]. Future longitudinal research should be conducted to confirm how health and wellness programs impact the flexibility of police officers. Nevertheless, improving flexibility should be beneficial to an officer's health and well-being, in addition to their job performance.

Grip strength significantly increased in 2020 compared to 2018. In addition to indicating upper-body strength [47], grip strength contributes to several policing tasks, including firearm use, defensive tactics [9], and body or victim drags [10]. As resistance testing and training was part of the health and wellness program, it is possible that this contributed to the increase seen in the sample of officers. Grip strength could be targeted in different resistance training exercises, including the deadlift and farmer's walk [57]. Future research could track individual officers to detail whether their grip strength does increase within the course of participation in a health and wellness program. Nonetheless, the data suggests that this type of program could impact grip strength, which could then enhance job task performance [9, 10].

The significant increase in systolic BP in 2020 compared to data from officers in 2018 and 2019 was notable. BP is an important measure for law enforcement personnel as it can be an indicator for cardiovascular disease [58]. Additionally, law enforcement personnel are at high risk for cardiovascular disease due to numerous factors including stress, shift work, lack of sleep, and dietary choices [13, 14, 17]. The environment in which the officers were working in 2020 could have heavily influenced these results. The COVID-19 pandemic occurred through 2020, and there were numerous instances of civil unrest in major US cities [59, 60]. Officers working through the pandemic likely experienced high stress [61, 62], and this could be reflected in the BP measurements. It should be noted that BP in 2020 was measured via a different method compared to the other years in this investigation (i.e., electronic vs. manual). Nonetheless, it should be noted that even with the increase in 2020, through all the years of data collection many of the officers had elevated BP (or greater) above normal levels [21]. While this may be due to how the data was collected (i.e., officers were tested at different times of day, and may have been reporting to the location following a work shift), the BP data was still indicative of police populations [63]. This highlights the need for officers to improve, or at the very least maintain, their aerobic fitness to reduce their risk of elevated BP and potentially cardiovascular disease [64]. Given the job itself may facilitate these conditions [13, 14], departments and individual officers could try to mitigate these risks via health and wellness programs.

While no comparative data were available to directly compare the impacts of participation in the health and wellness programs versus non-participation, the benefits of the program may be highlighted by comparison against other agencies who are not participating in such a program. Research by Dawes et al. [15], profiling officers in a state patrol agency, found that officers recorded mean push-up repetitions of 24.24 ± 11.63 (29 female officers) to 39.09 ± 15.61 repetitions (582 male officers), scores well below the combined male and female officers mean scores reported in this study (43.94 ± 18.40 repetitions in 2018, to 48.36 ± 18.60 repetitions in

2020). A similar difference was found when comparing sit up scores with the officers. In the study by Dawes et al. [15], the authors reported sit-up ranges of 31.06 ± 9.52 repetitions (33 female officers) to 34.46 ± 10.29 repetitions (583 male officers) compared to ranges of 41.40 ± 11.70 repetitions (2018) to 45.15 ± 24.62 (2019) repetitions reported in this study.

Further to this, except for BP, officers that participated in the health and wellness program tended to have a better health and fitness profile relative to the general population. It should be noted that these programs are typically voluntary or incentivised [19], and officers who are fitter and healthier may be more likely to participate in health and wellness programs. Nonetheless, there were still officers that did have poorer health and fitness profiles but were part of the program. For example, even though between 61-68% of the officers across the 3 years were categorised as average-to-very lean with regards to BF% [23], there were several females considered as overfat when considering the general population norms (e.g. ~51% of the females in 2019). Although it cannot be confirmed with the current data, it could still be a positive that these officers are involved in the program. It could be that participation in the health and wellness program is part of lifestyle change, and that the officers are attempting to reduce their body fat. This is part of the reason why health and wellness programs are recommended for law enforcement personnel [19, 20]. Behaviour change can be a slow process with regards to exercise adherence [65], so integrating these officers into a health and wellness program should be beneficial for their future well-being.

Aerobic capacity contributes to numerous policing tasks, such as load carriage [66], running-based activities, and endurance exercise [3, 8, 11]. Good aerobic fitness can also lower the chance of cardiovascular disease [67], which is an important consideration for police populations. In 2018 and 2019, over 90% of the sample were classified as having a good-to-superior estimated $\dot{V}O_{2max}$ [22]. The sample was much smaller for this variable in 2020 (n = 10), but all these officers also had good-to-superior estimated $\dot{V}O_{2max}$ [22]. There are several reasons why these results may have occurred. Aerobic conditioning is commonly a focus in recruit training academies [49], so officers should have some understanding of the importance of this fitness quality. This would be further re-emphasised by health and wellness programs, where cardiovascular fitness is typically a component part [19, 20]. However, previous research has also shown that the Gerkin protocol can overestimate $\dot{V}O_{2max}$ in apparently healthy men and women [37]. This could have influenced the results from this study, in that the officers may have been rated as higher than what their actual $\dot{V}O_{2max}$ was. Nonetheless, the mean estimated $\dot{V}O_{2max}$ for the officers in this study (~54-56 $ml \cdot kg^{-1} \cdot min^{-1}$) was greater than that for firefighters assessed with the same protocol (~50 $ml \cdot kg^{-1} \cdot min^{-1}$) [37, 40]. This provides some indication as to the high levels of aerobic fitness demonstrated by the officers in this study. As previous research has shown aerobic capacity can decline over an officer's career [14] and with age [15, 16], if officers within a health and wellness program can maintain (or improve) this quality this should help their career longevity and overall well-being.

Upper-body and abdominal endurance contributes to important patrol job tasks, including lifting, carrying, pushing, dragging, running, and obstacle clearance [3-6, 8, 11]. Push-ups and sit-ups are also staple exercises within many police training academies [49], so many officers should have experience completing these exercises. Accordingly, almost all the officers within the program were classified as good-to-excellent in push-ups [22]. Although only one officer was classified as well above average, 83-86% of officers were rated as average or above average over the 3 years [23]. These are prominent findings, especially considering numerous studies have indicated performance in muscular endurance tests such as push-ups and sit-ups tends to decline with age [15, 16] and as a result of policing job duties (e.g., more sedentary behaviours, reduction in physical activity) [14]. Participation in a health and wellness program could contribute to the maintenance, and potential improvement, of muscular endurance measured by push-ups and sit-ups. This should ultimately benefit the job performance and career longevity of police officers.

Grip strength and the bench press ratio provide measures of upper-body strength. Both grip and upper-body pushing strength contribute to numerous policing job tasks, including load carriage, defensive tactics, firearm use, and dragging tasks [9, 10, 66]. Accordingly, if officers had good strength profiles, this could have a great impact on their occupational effectiveness. For grip strength, 69-83% of officers were classified as good-to-excellent [22], with the highest percentage occurring in 2020. Across the 3 years, approximately 90% of the officers were classified as good-to-superior in the bench press ratio [22]. These results indicate that compared to the general population, most officers within the health and wellness program demonstrated good grip and upper body pushing strength. These results are important as maximal strength training is not often a focus of police training academies [3], so personnel may not always be exposed to how this type of training can benefit their careers. Previous research has shown resistance training can improve maximal strength in recruits [48, 68] and officers [69]. Although further research is required, the data from the current research suggest that health and wellness programs could positively impact the strength of officers.

Lower-body power supports job tasks such as obstacle clearance, victim or body drags, and foot pursuits [6, 8, 12]. This quality is commonly inferred from vertical jump height [44]; however, normative data for the vertical jump relative to the general population was not available in the context of this study. Nonetheless, the data can be compared to that from other law enforcement personnel. For example, the vertical jump recorded for the officers in this research (mean jump height of ~54-56 cm across the 3 years) was similar to that from recruits at the start of academy training (~54 cm) [6]. As previous research has shown that when compared to recruits, incumbent officers tend to have lesser fitness [14], these data highlight the potential value of health and wellness programs. If the officers from this department can generate comparable lower-body power to recruits, this would suggest that they have maintained this quality to some extent during their career. This should mean that when the officer needs to generate lower-body power when on-duty (e.g., sprinting to pursue an offender, jumping to clear an obstacle), they should have a greater capacity to do so. Whether this is due to health and wellness program participation needs to be confirmed via a longitudinal study with a comparative control group of officers. Nevertheless, the data suggests that officers within this type of program can have a vertical jump comparable to recruits at the start of academy [6].

There are limitations with this study that should be noted. The COVID-19 pandemic impacted data collection in 2020. This included using different methods for measuring BP, as well as the removal of the estimated $\dot{V}O_{2max}$ treadmill test. As health and wellness programs are typically voluntary and incentivised [19], the officers that participate may already be generally healthy and fit, or at least have a predisposition to maintaining or improving their health and fitness. Officers that are less fit, or have poorer health, may choose not to participate, and they may not be reflected within the data shown by this study. The data analysis was cross-sectional across each year. Future research should track individual officers across their time spent participating within a wellness program with a comparative control group not involved with the program. Although difficult, future research should attempt to incorporate more officers into analyses of health and wellness. However, it should be noted that this would be extremely challenging, as these types of assessments generally cannot be mandatory. Even though some data may be generalisable from the police department in this study, it would be beneficial for other departments to specifically analyse their own personnel.

Within the context of these limitations, there are several practical applications that can be drawn from this research. Police command staff should consider implementing health and wellness programs within their department. The data from this study suggested that most officers who participated in the health and wellness program demonstrated health and fitness profiles that were good compared to the general population. The data also provided some documentation as to the stressful reality of police work (i.e., many officers had relatively higher blood pressure). If anything, this places even more importance for the use of health and wellness programs. The types of strategies commonly featured in these programs (e.g., exercise and fitness testing, chronic disease prevention, alcohol and drug use interventions, nutrition, body weight management, injury prevention, and stress management) [19, 20] could alleviate some of the negative impacts of police work. Within a department, it would be beneficial to encourage widespread participation for officers within a health and wellness program. This could lead to greater benefits relative to health, fitness, and overall well-being for more officers within a department.

5. Conclusion

The results presented in this study indicate that from 2018 to 2020, there were few significant differences between the health and fitness officers tested within a health and wellness program for a large city police department. The officers in 2020 did have a superior sit-and-reach (greater hamstring flexibility) and greater grip strength, providing some evidence of the potential effectiveness of health and wellness programs for police officers, noting that even maintaining fitness over years highlights program benefits. Systolic BP was higher in 2020, which may have been a function of occupational stressors associated with this year (pandemic, civil unrest). Overall, the officers tended to have elevated BP, which highlights the importance of health and wellness programs. When compared to general population norms, the officers tended to have good health and fitness profiles. Nonetheless, the presence of officers with lesser health and fitness should not be viewed as a negative, as their participation in the health and wellness program may be an attempt to encourage lifestyle change. Although further research is required, this study suggests that a health and wellness program could be beneficial for police officers and could contribute to better health and fitness profiles.

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Conflict of Interest

This study received no external financial assistance. None of the authors have any conflict of interest.

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Table 1. Descriptive data (mean ± SD) for body mass, body fat percentage (BF%), systolic and diastolic blood pressure (BP), estimated maximal aerobic capacity ($\dot{V}O_{2max}$), sit-and-reach, push-ups, vertical jump, combined grip strength, sit-ups, and bench press ratio (one-repetition maximum load relative to body mass) for law enforcement officers who participated in a health and wellness program in 2018, 2019, and 2020. The number of officers (n) with data per year is also noted for each variable in respective order.

	2018	2019	2020
Age (years; n = 209, 238, 186)	39.48 ± 8.49	38.81 ± 8.66	40.76 ± 7.81
Body Mass (kg; n = 209, 237, 186)	86.62 ± 17.28	85.90 ± 14.70	86.08 ± 15.07
BF% (n = 209, 235, 186)	22.54 ± 9.29	22.15 ± 8.56	21.24 ± 8.28
Systolic BP (mmHg; n = 209, 238, 186)	124.69 ± 9.30	123.43 ± 9.53	133.32 ± 12.50*§
Diastolic BP (mmHg; n = 209, 238, 186)	78.98 ± 6.59	79.62 ± 6.50	81.19 ± 9.74
Estimated $\dot{V}O_{2max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$; n = 208, 231, 10)	53.89 ± 9.22	53.71 ± 8.94	56.25 ± 8.99
Sit-and-Reach (cm; n = 208, 237, 184)	30.01 ± 8.80	30.36 ± 8.39	31.43 ± 8.01ϕ
Push-ups (repetitions; n = 208, 234, 181)	43.94 ± 18.40	45.96 ± 18.30	48.36 ± 18.60
Vertical Jump (cm; n = 205, 233, 184)	56.73 ± 13.35	57.12 ± 11.28	54.92 ± 13.10
Grip Strength (kg; n = 209, 238, 185)	91.43 ± 21.09	94.50 ± 22.29	98.72 ± 21.06ϕ
Sit-ups (repetitions; n = 189, 192, 155)	41.40 ± 11.70	45.15 ± 24.62	43.56 ± 10.21
Bench Press Ratio ($kg \cdot body\ mass^{-1}$; n = 209, 237, 183)	1.12 ± 0.31	1.11 ± 0.31	1.12 ± 0.27

* Significantly ($p < 0.01$) different from 2018 data.

ϕ Significantly ($p < 0.05$) different from 2018 data.

§ Significantly ($p < 0.01$) different from 2019 data.

FIGURE LEGEND

Figure 1. Number of police officers classified according to the percentage of fat mass categories.

Figure 2. Number of police officers classified according to the blood pressure categories.

Figure 3. Number of police officers classified according to the maximal aerobic capacity categories.

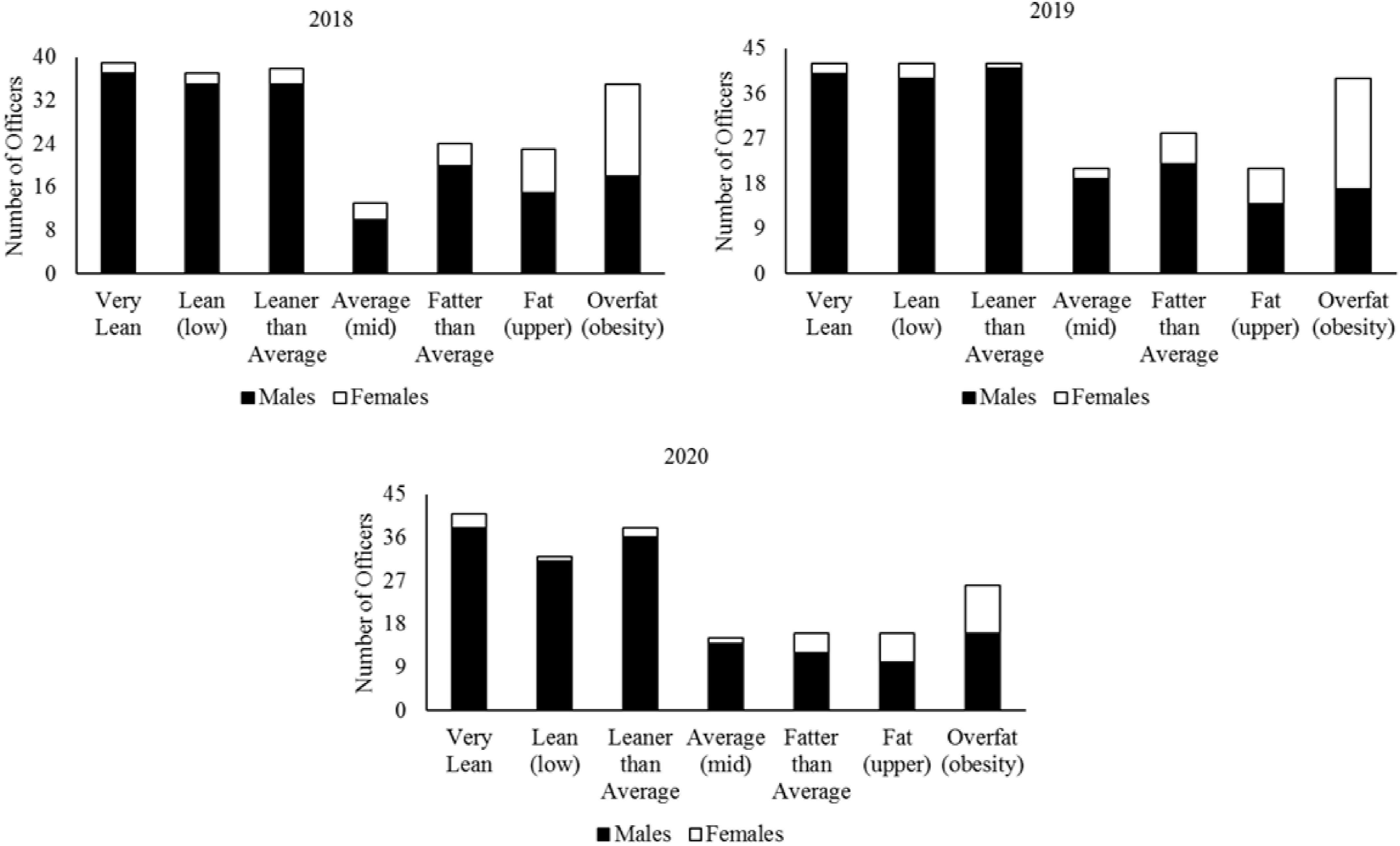
Figure 4. Number of police officers classified according to the sit-and-reach categories.

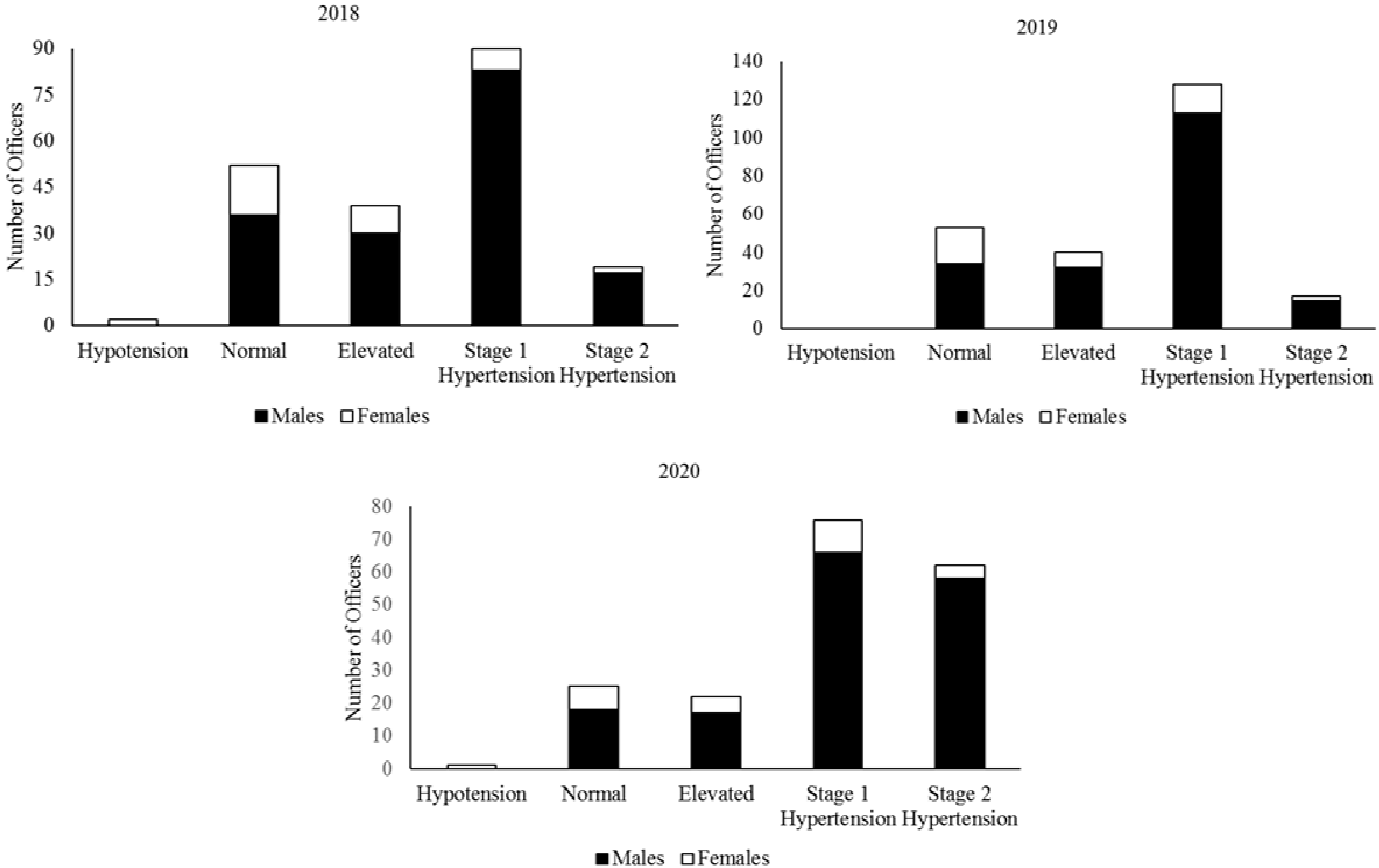
Figure 5. Number of police officers classified according to the push-up categories.

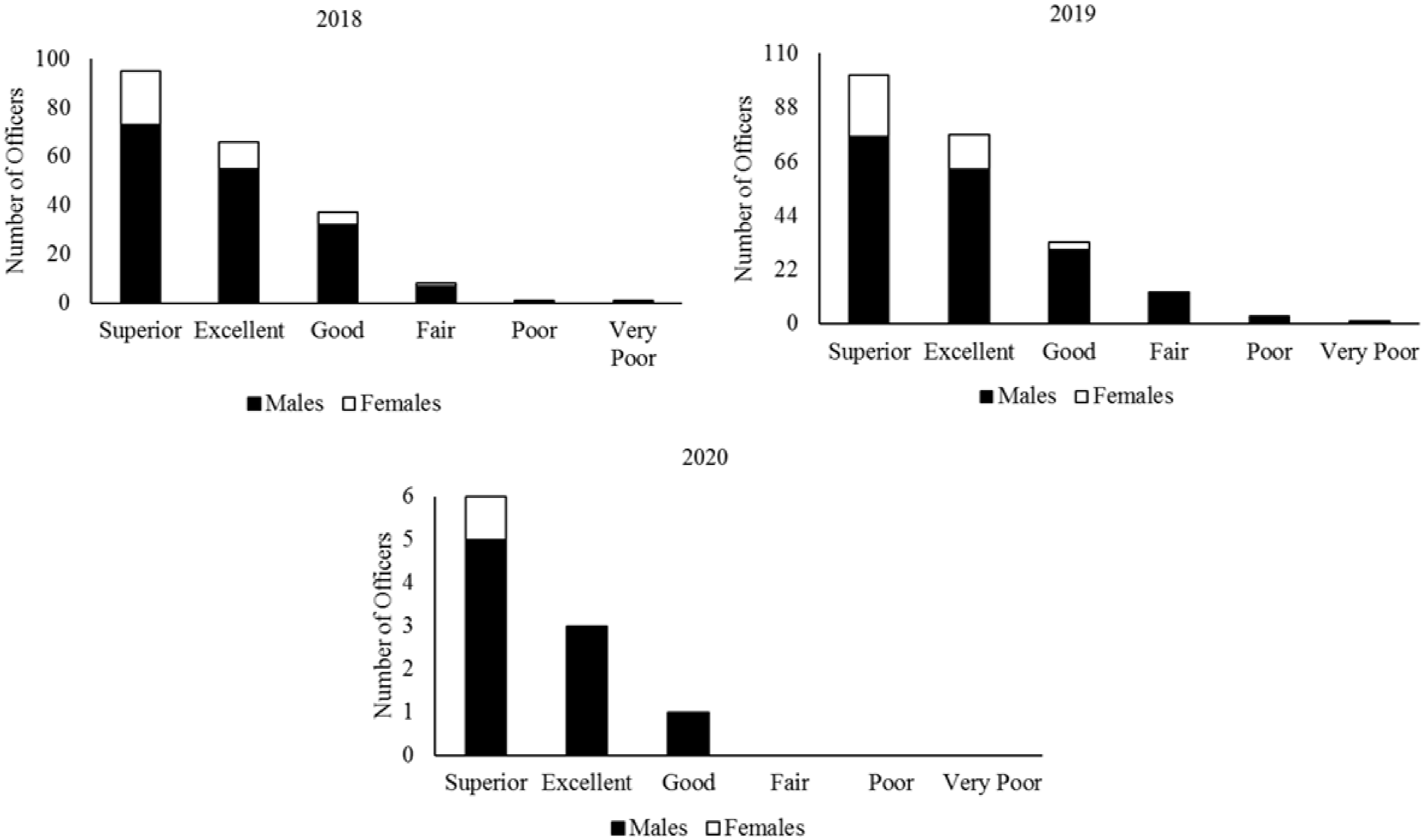
Figure 6. Number of police officers classified according to the grip strength categories.

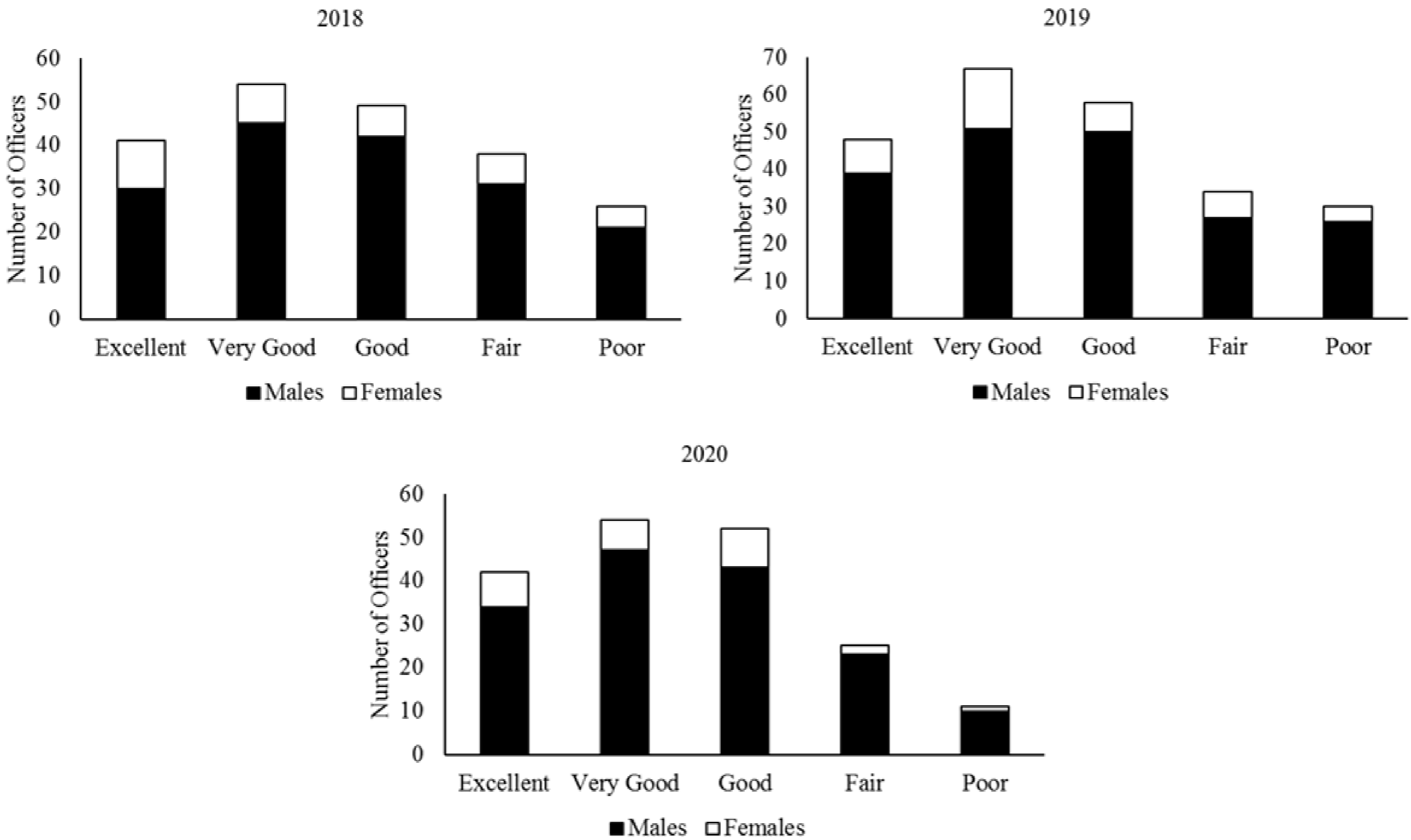
Figure 7. Number of police officers classified according to the sit-up categories.

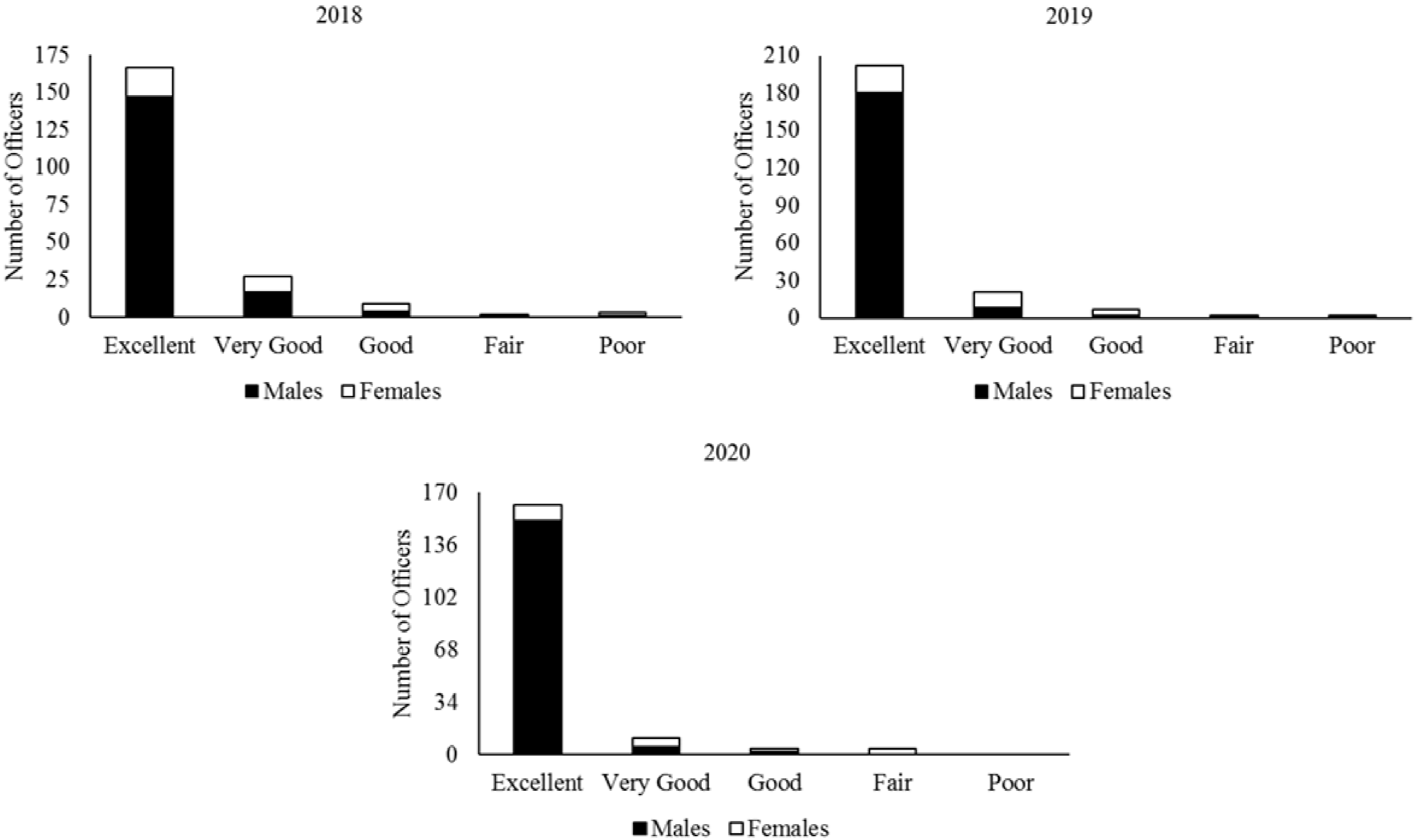
Figure 8. Number of police officers classified according to the bench press ratio categories.

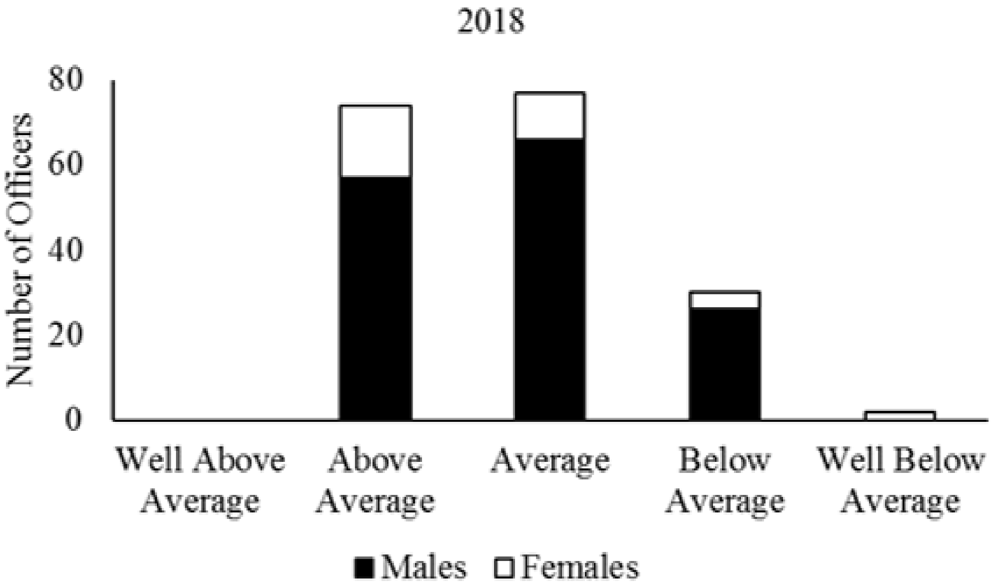

2018
Number of Officers
0
8
16
24
32
40
Very Lean
Lean (low)
Leaner than Average
Average (mid)
Fatter than Average
Fat (upper)
Overfat (obesity)
Males
Females
2019
Number of Officers
0
9
18
27
36
45
Very Lean
Lean (low)
Leaner than Average
Average (mid)
Fatter than Average
Fat (upper)
Overfat (obesity)
Males
Females
2020
Number of Officers
0
9
18
27
36
45
Very Lean
Lean (low)
Leaner than Average
Average (mid)
Fatter than Average
Fat (upper)
Overfat (obesity)
Males
Females

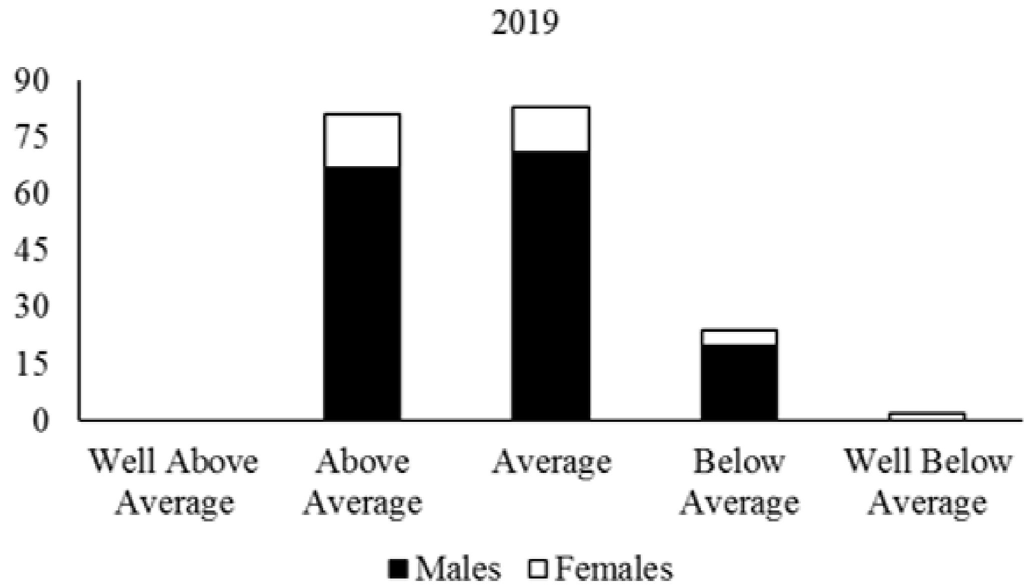

2018
Number of Officers
90
75
60
45
30
15
0
Hypotension
Normal
Elevated
Stage 1 Hypertension
Stage 2 Hypertension
Males
Females
2019
Number of Officers
140
120
100
80
60
40
20
0
Hypotension
Normal
Elevated
Stage 1 Hypertension
Stage 2 Hypertension
Males
Females
2020
Number of Officers
80
70
60
50
40
30
20
10
0
Hypotension
Normal
Elevated
Stage 1 Hypertension
Stage 2 Hypertension
Males
Females

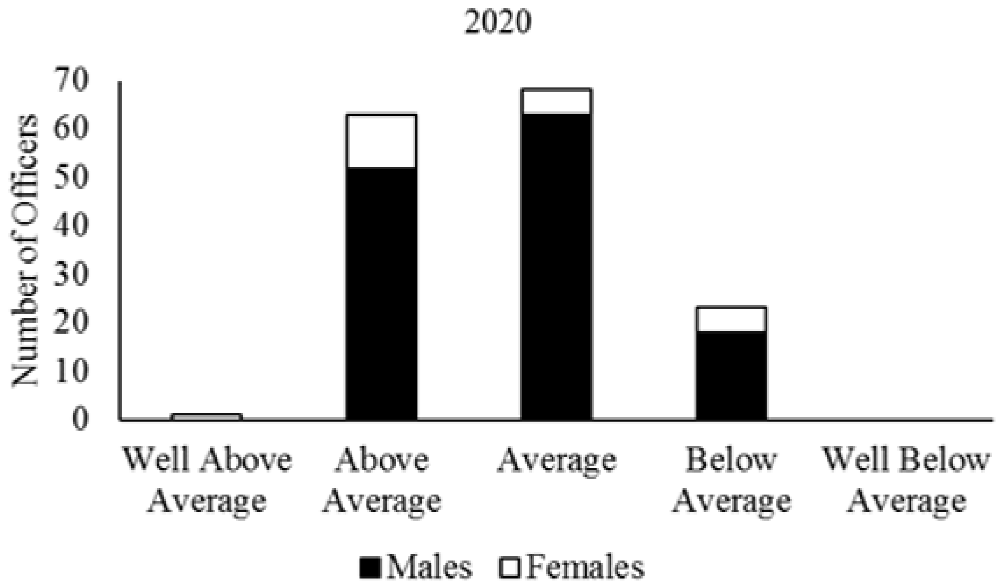

2018
Number of Officers
100
80
60
40
20
0
Superior
Excellent
Good
Fair
Poor
Very Poor
Males
Females
2019
Number of Officers
110
88
66
44
22
0
Superior
Excellent
Good
Fair
Poor
Very Poor
Males
Females
2020
Number of Officers
6
5
4
3
2
1
0
Superior
Excellent
Good
Fair
Poor
Very Poor
Males
Females

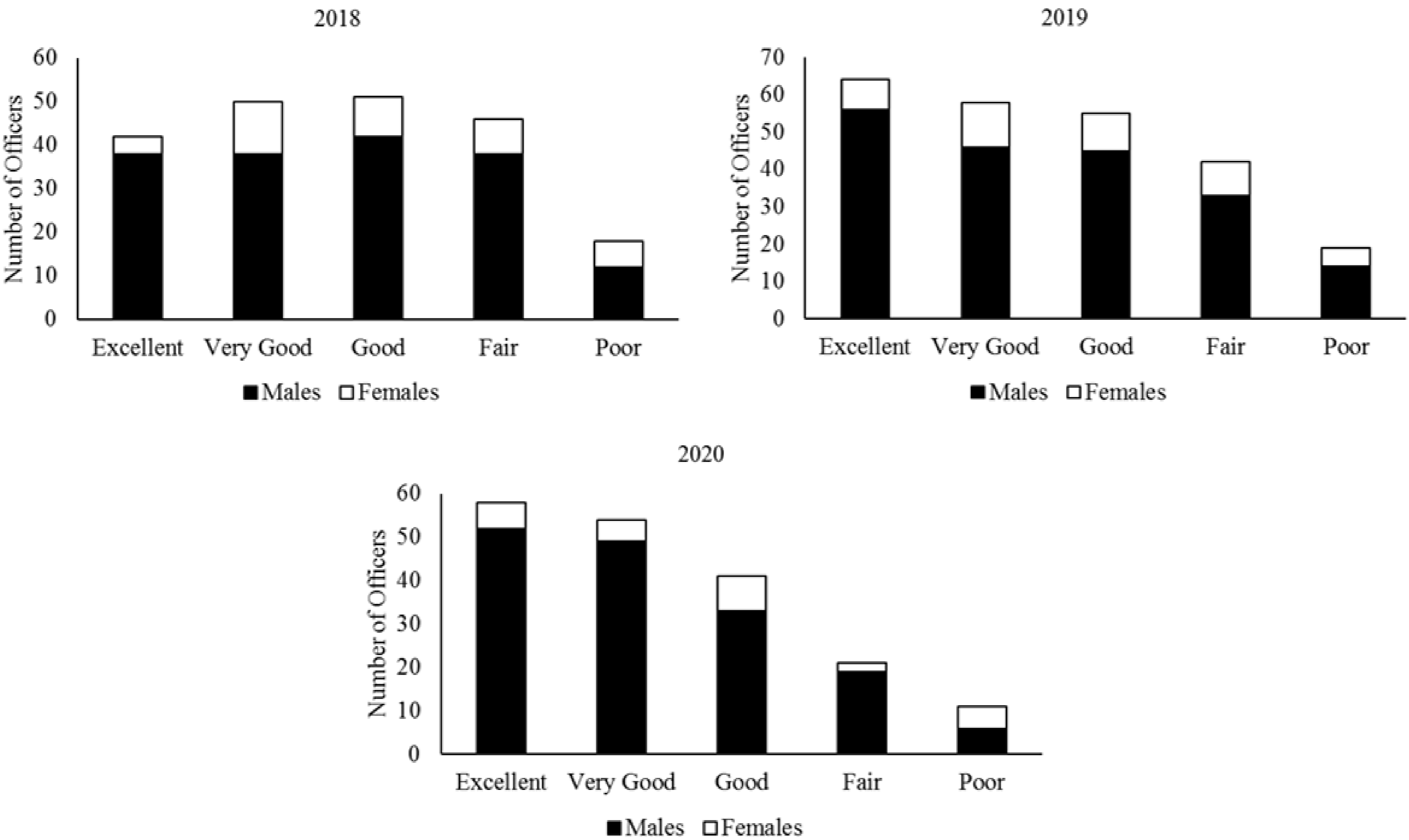

2018
Number of Officers
0
10
20
30
40
50
60
Excellent
Very Good
Good
Fair
Poor
Males
Females
2019
Number of Officers
0
10
20
30
40
50
60
70
Excellent
Very Good
Good
Fair
Poor
Males
Females
2020
Number of Officers
0
10
20
30
40
50
60
Excellent
Very Good
Good
Fair
Poor
Males
Females

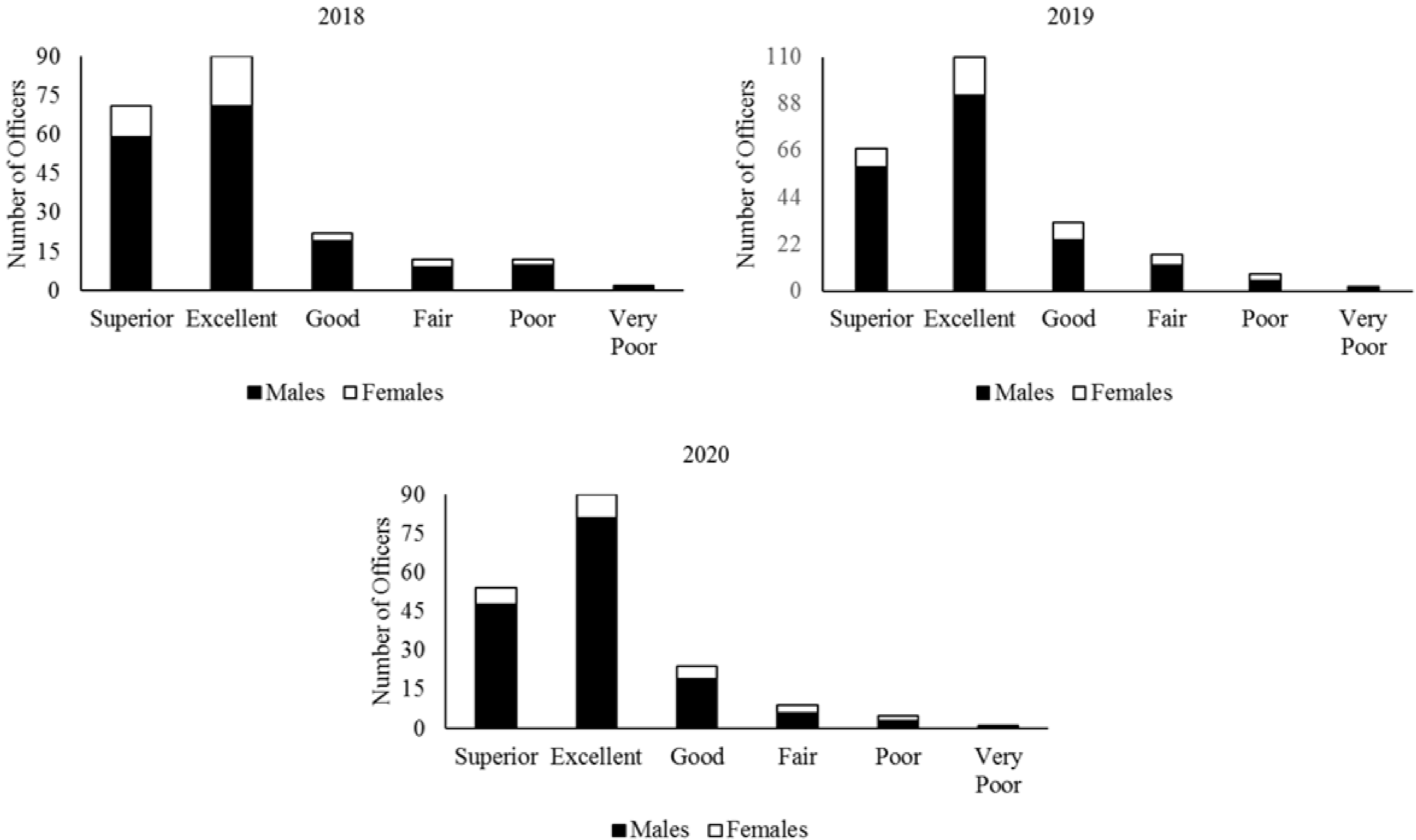

2018
175
150
125
100
75
50
25
0
Number of Officers
Excellent
Very Good
Good
Fair
Poor
Males
Females
2019
210
180
150
120
90
60
30
0
Number of Officers
Excellent
Very Good
Good
Fair
Poor
Males
Females
2020
170
136
102
68
34
0
Number of Officers
Excellent
Very Good
Good
Fair
Poor
Males
Females


2018
Number of Officers
0
20
40
60
80
Well Above Average
Above Average
Average
Below Average
Well Below Average
Males
Females


2019
0
15
30
45
60
75
90
Well Above Average
Above Average
Average
Below Average
Well Below Average
Males
Females


2020
Number of Officers
0
10
20
30
40
50
60
70
Well Above Average
Above Average
Average
Below Average
Well Below Average
Males
Females


2018
Number of Officers
60
50
40
30
20
10
0
Excellent
Very Good
Good
Fair
Poor
Males
Females
2019
Number of Officers
70
60
50
40
30
20
10
0
Excellent
Very Good
Good
Fair
Poor
Males
Females
2020
Number of Officers
60
50
40
30
20
10
0
Excellent
Very Good
Good
Fair
Poor
Males
Females


2018
Number of Officers
90
75
60
45
30
15
0
Superior
Excellent
Good
Fair
Poor
Very Poor
Males
Females
2019
Number of Officers
110
88
66
44
22
0
Superior
Excellent
Good
Fair
Poor
Very Poor
Males
Females
2020
Number of Officers
90
75
60
45
30
15
0
Superior
Excellent
Good
Fair
Poor
Very Poor
Males
Females