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THE RELATIONSHIP BETWEEN CHRONOTYPES AND
CARDIOVASCULAR DISEASE RISK FACTORS AMONG
LAW ENFORCEMENT OFFICERS

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THE RELATIONSHIP BETWEEN CHRONOTYPES AND CARDIOVASCULAR DISEASE
RISK FACTORS AMONG LAW ENFORCEMENT OFFICERS

by

ALYSSA FAIL

(Under the Direction of Bridget Melton)

ABSTRACT

Much of the data associated with cardiovascular disease risk factors and circadian rhythms are done on shift workers; due to their line of work typically causing circadian disruption and sleep loss (Loef et al., 2019). Previous research incorporating chronotype and its influence on shift work has been explored; however, there is limited research focusing on law enforcement officers. Additionally, no known research has investigated the effect of chronotype on CVD risk factors among law enforcement officers. The aim of this study was to investigate the cardiovascular disease risk factors in law enforcement officers and their relationship with chronotypes. This cross-sectional study, utilized a convenience sample of adult male and female police officers (n = 36) from one southeast Georgia sheriff department. Chronotypes were assessed using the Reduced Morning Evening Questionnaire (rMEQ), additionally blood pressure and blood lipid panel were measured. rMEQ categorized the LEOs into Morning (n=11), Intermediate (n=16), and Evening Type (n=9). Results show no significant difference found between chronotypes related to cardiovascular health. However, descriptive findings highlight the elevated cardiovascular risk among LEOs. Future research should focus on other factors that relate to chronotypes such as stress or the level of involvement to have a range of all chronotypes and different scales of health for individuals.

INDEX WORDS: Law enforcement officers, Cardiovascular disease, Chronotype

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by

ALYSSA FAIL

B.S., Georgia Southern University, 2021

A Dissertation Submitted to the Graduate Faculty of Georgia Southern University

in Partial Fulfillment of the Requirements for the Degree

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Electronic Version Approved:

May 2023

DEDICATION

This study is dedicated to the people in my life and at Georgia Southern who have provided nonstop support throughout my educational journey. Thank you for all the support and for staying with me during this time.

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I would like to acknowledge and give my warmest thanks to my committee chair, Dr. Melton, who gave me access to her law enforcement population and made all of this work possible. Her guidance and advice helped me through every stage of this process and introduced me to data collection and a new population I had yet to work with. She inspired me and provided wonderful feedback throughout this time and got me prepared for my future endeavors. I would also like to thank my committee members for letting my writing process be enjoyable and pushing me to become a better writer. Dr. Romanchik and Dr. Grosicki, thank you for always pushing me to think outside the box, and become more confident in my work.

I would also like to give thanks to all the professors and students I have been able to work with throughout my time at this school and being able to push each other to be better. Everyone was a big help in shaping me into the person I am today and I could not be more thankful for the friends I am walking away with after my time at Georgia Southern. Professors and students alike have given me new perspectives and experiences I would never have imagined by myself.

I would like to give a special thanks to the law enforcement officers that volunteered to participate in this study, making this all possible. Working with them has given me a new perspective on their work and allowed me to understand everything they do.

Lastly I would like to give a special thanks to my wonderful family for pushing me to continue my studies and ending up where I am now.

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CHAPTER 1

BACKGROUND

Purpose of the Study

The purpose of this study is to investigate the relationship between chronotypes and cardiovascular disease (CVD) risk factors among law enforcement officers. Much of the data associated with cardiovascular disease risk factors and circadian rhythms are done on shift workers; due to their line of work typically causing circadian disruption and sleep loss (Loef et al., 2019). When assessing chronotype, there are questionnaires that individuals can answer to determine what their chronotype is, specifically, for this study, the rMEQ was used. After taking the assessment, it breaks into three sections Morning (MT), Intermediate (IT), and Evening Type (ET). ETs have been shown to have an increased rate of obesity, type 2 diabetes, and hypertension in comparison to MT (Wong et al., 2015; Yu et al., 2015). They also have significantly higher levels of triglycerides, high-density lipoprotein cholesterol, and metabolic syndrome scores (Vera et al., 2018).

How This Study Is Original

This study examines the relationship between chronotypes and the risk of CVD in law enforcement officers. These officers took the rMEQ, which allowed them to discover their own chronotype.

CHAPTER 2

INTRODUCTION

Shift work is an essential part of our society, with a wide variety of professions running 24/7, including medical personnel, first responders, transportation, food service, the hospitality industry, and many other occupations. Although shift work is necessary, many individuals may struggle with their wake-sleep cycles based on their body's natural tendencies of alertness, referred to as chronotype (Pacheco, 2022). Martin et al. (2015) define chronotype as the relationship between one's sleep-wake cycle. Simply put, chronotype would classify someone as an early bird or night owl. Chronotyping has recently received attention for its influence on cardiovascular disease (Makarem, Paul, Viardina, Liao, and Aggerwall, 2020), specifically among law enforcement officers (LEOs) (Kervezee, Gonsales-Aste, Boudreau and Boicin, 2021).

LEOs perform unpredictable amounts of intense and laborious physical activity, which places a high demand on the cardiovascular system (Zimmerman, 2012). However, LEOs display some of the worst CVD health profiles of any occupation, including the rate of CVD risk factors, evident CVD, and on-duty CVD events (Zimmerman, 2012). Shift work with law enforcement has been shown to increase the risk of cardiovascular disease, particularly with increasing years of exposure (Torquati et al., 2018). Along with an increase in CVD among LEO, the underlying risk factors are elevated, including obesity, hypertension, and hyperlipidemia.

Obesity

Obesity prevalence in LEOs is consistently higher compared to aged-matched non-sworn or office worker professions (Strauss et al., 2021; Raju, Tiwari, Verman, and Kumari, 2017). Obesity is a complex condition with a wide range of contributors, including long sedentary time,

lack of physical activity, poor nutritional behavior, and lack of sleep which is often associated with law enforcement (MacKenzie-Shalders et al., 2022). Evidence shows that short sleep cycles contribute to multiple health issues, including obesity and CVD (Hittle & Gillespie, 2018). Working longer hours and the midnight shift was significantly associated with larger waist circumference and higher BMI in male police officers (Gu et al., 2012). Many adverse outcomes, such as obesity, are explicitly linked to a mismatch between chronotype and work schedule. (Pacheco, 2022).

Hypertension

In addition to obesity, high blood pressure is strongly linked to CVD (Fuchs et al., 2019). Kales et al. (2009) found the majority of emergency responders to be prehypertension or hypertension; further, those with inadequately controlled BP had a strong link to cardiovascular disease morbidity and mortality. Yates et. al. (2021) revealed a significant difference in hypertension with 60.5% and 20% operational (n=77) and 60.0% and 13.6% of non-operational (n=60) police personnel, respectively (p>0.05).” Compounding the problem, shift workers with morning chronotypes to intermediate specifically have poor sleep quality, which contributes to high blood pressure (McMahon et al., 2019). Officers with sleep problems are at a higher risk of hypertension, leading to an increased risk of CVD.

Dyslipidemia

Another risk factor for CVD is dyslipidemia, where the blood lipid levels are higher or lower than recommended for cardiovascular health. Evidence has shown that LEOs often present with dyslipidemia; one study found mean total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-C), low-density lipoprotein-cholesterol (LDL-C), and triglyceride (TG) levels were 187.5, 43.9, 119.5 and 124.5 mg/100 ml, respectively (Alghamid et al., 2017).

Further, Tomizawa, (2019) highlighted that evening shift workers are more likely to have elevated blood lipid levels compared to morning and intermediate chronotypes, which may exacerbate the risk of CVD for LEOs.

Gaps in Research

Shift work for police officers can negatively affect their sleep (Lockie et al., 2022; Garbarino, et al., 2019). When looking at law enforcement and their sleep schedules, it is important to consider their respective chronotype. Using the officer's chronotype to help make schedules may influence their productivity on shift because they will be working with their natural sleep cycle rather than working against it. Previous research incorporating chronotype and its influence on shift work has been explored; however, there is limited research focusing on law enforcement officers. Additionally, no known research has investigated the effect of chronotype on CVD risk factors among law enforcement officers.

Purpose

The purpose of this study is to investigate the relationship between chronotypes and cardiovascular disease risk factors among law enforcement officers.

Research Questions

R1: Is there a relationship between chronotype and CVD risk in law enforcement officers?

Hypothesis

H1null: There is no relationship between chronotype and CVD risk in law enforcement officers.

H1: There is a relationship between chronotype and CVD risk in law enforcement officers.

Chapter 3

METHODS

The study employed a cross-sectional design with a convenience sample. The study was approved by the university's institutional review board, H19098, prior to any data collection. All participants signed informed consent to release their deidentified data for analyses for study purposes.

Participants

As part of a department-wide annual health and fitness assessment, 55 law enforcement officers from one southeast law enforcement agency volunteered to release their de-identified information for this study. Of these 55, 36 officers completed all testing procedures and online questionnaires. Demographics such as age, gender, race, and years of service were obtained via self-report in a prescreening survey.

Protocol/Measurements

On the testing day, the participants were asked to come in fasted, as well as refraining from alcohol or tobacco use at least 12 hours prior to their visit. Upon arriving at the testing center, participants' resting blood pressure was taken after five minutes of rest in a seated position. Blood pressure was measured in accordance with the American College of Sports Medicine (ACSM) Guidelines for Exercise Testing and Prescription (Liguori et al., 2022). Following all the guidelines for taking blood pressure, measurements were taken twice within one minute apart. To obtain weight and body composition, participants were instructed to remove shoes and socks, and any accessories that may cause measurement inaccuracies. Self-reported heights were used for the electronic scale/ bioelectric impedance machine (TBF300 WA, Tanita Corporation, Tokyo, Japan). The values obtained from these devices were used to

calculate body mass index (BMI) and body composition. Waist circumference was measured using a standard cloth tape and measured around the center of the abdomen, in line with the umbilicus.

Blood lipids levels were collected using the Cholestech LDX. The Cholestech LDX is used for the quantitative determination of total cholesterol (TC), Low density and high density lipoproteins (LDL and HDL), triglycerides (TG), and glucose. These analytes are measured simultaneously from a single drop of blood using the Cholestech LDX Analyzer (Guisto, 2017).

To determine chronotype, participants were asked to complete a revised version of the reduced (5-item) form of the Morningness-Eveningness Questionnaire (rMEQ) as part of the prescreen surveys. The rMEQ is a self-report questionnaire with a final score ranging from 4 to 26: according to the scale, a score <12 indicates an evening type (ET); 12–17 a neither or intermediate type (IT); >17 a morning type (MT) (Danielsson et al., 2019). This questionnaire has internal consistency with a Cronbach's alpha of .68 (Danielsson et al., 2019).

Analysis

Descriptive statistics were calculated for age, race, years of service, BMI, and body fat percentage. All values are expressed as means \pm SD. Analyses were performed with SPSS version 28 (SPSS Inc, Chicago, IL). Three multivariate analysis of variance was conducted to analyze the chronotype and cardiovascular disease risk measures. Alpha was set at $p < 0.05$.

CHAPTER 4

RESULTS

The sample demographics and characteristics are described in Table 1. Of the 55 participants, 36 of the participants completed all testing procedures including the questionnaire. Of this subset, 88.9% (n = 32) were white, 5.5% (n = 2) were black, 2.8% (n = 1) were Hispanic, and 2.8% (n = 1) were others. Participants were both male (n=30) and female (n=6).

Table 1. Sample demographics and cardiovascular health

Variable	<i>n</i>	<i>M</i>	<i>SD</i>
Age (years)	36	42.72	9.24
BMI (kg/m ²)	36	31.63	6.00
BF %	36	31.11	10.33
Years of service (years)	36	15.63	10.15
Waist Circumference (cm)	36	103.63	13.90
Systolic BP (mmHg)	36	142.25	14.75
Diastolic BP (mmHg)	36	89.28	8.07
LDL-C (mg/dL)	36	144.25	41.74

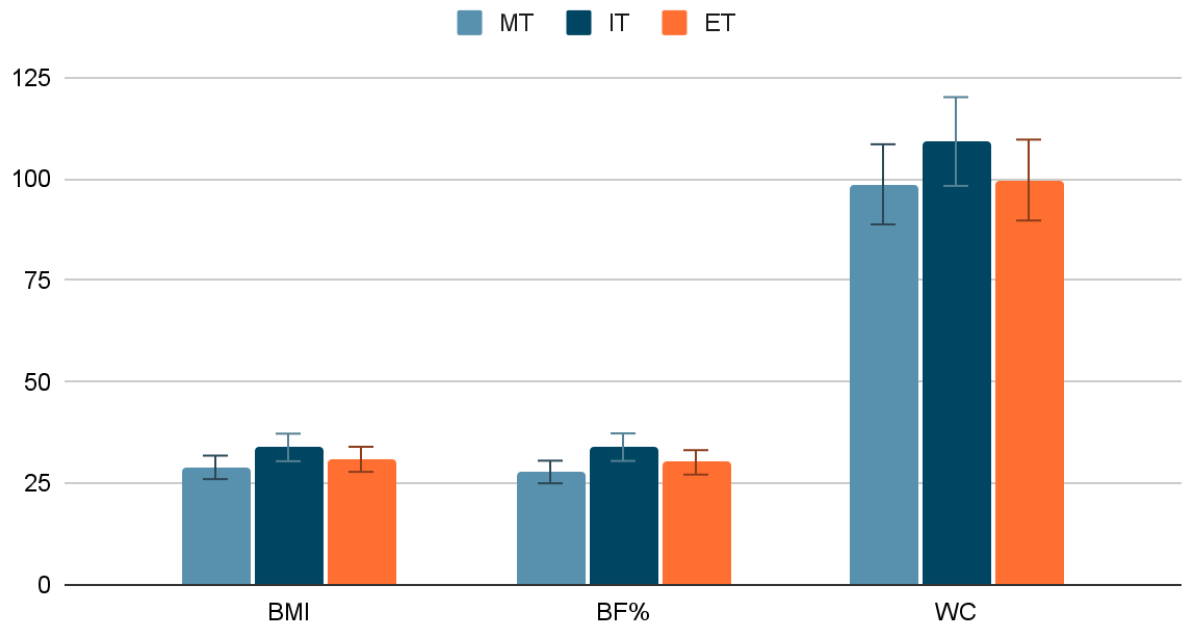
HDL-C (mg/dL)	36	41.08	12.30
TG (mg/dL)	36	126.67	58.16
Glucose (mg/dL)	36	104.36	32.82

BF% - Body Fat Percentage, LDL-C - Low-density Lipoprotein-Cholesterol, HDL-C - High-density Lipoprotein-Cholesterol, TG - Triglycerides

The tests are broken down into three categories, the first test examined body composition showing the averages of BMI, body fat percentage, and waist circumference. Figure 1 shows the three factors of body composition average within each chronotype. The average values for body composition are as follows, MT has an average of 28.96 BMI, 27.81 BF%, and 98.68cm WC. IT has an average of 33.85 BMI, 33.91 BF%, and 109.22cm WC. ET has an average of 30.93 BMI, 30.18 BF%, and 99.72cm WC. The next test looked at the average levels of SBP and DBP and compared them within the three chronotypes, shown in Figure 2. MT average blood pressure was 147.55 mmHg SBP and 88.09 mmHg DBP. IT average blood pressure was 144.88 mmHg SBP and 91.44 mmHg DBP. ET average blood pressure was 143.33 mmHg SBP and 86.89 mmHg DBP. Figure 3 showing the lipid panel averages within the separate chronotypes. The average values of the panel in MTs are 217.73 mg/dL TC, 149.45 mg/dL LDL, 136.36 mg/dL TG, 43.91 mg/dL HDL, and 99.36 mg/dL BG. ITs had an average of 207.31mg/dL TC, 147.63 mg/dL LDL, 140.13 mg/dL TG, 35.19 mg/dL HDL, and 102.31 mg/dL BG. ETs had an average of 198.11 mg/dL TC, 131.89 mg/dL LDL, 90.89 mg/dL TG, 48.11mg/dL HDL, and 114.11mg/dL BG.

Figure 1. Obesity indicators separated chronotype

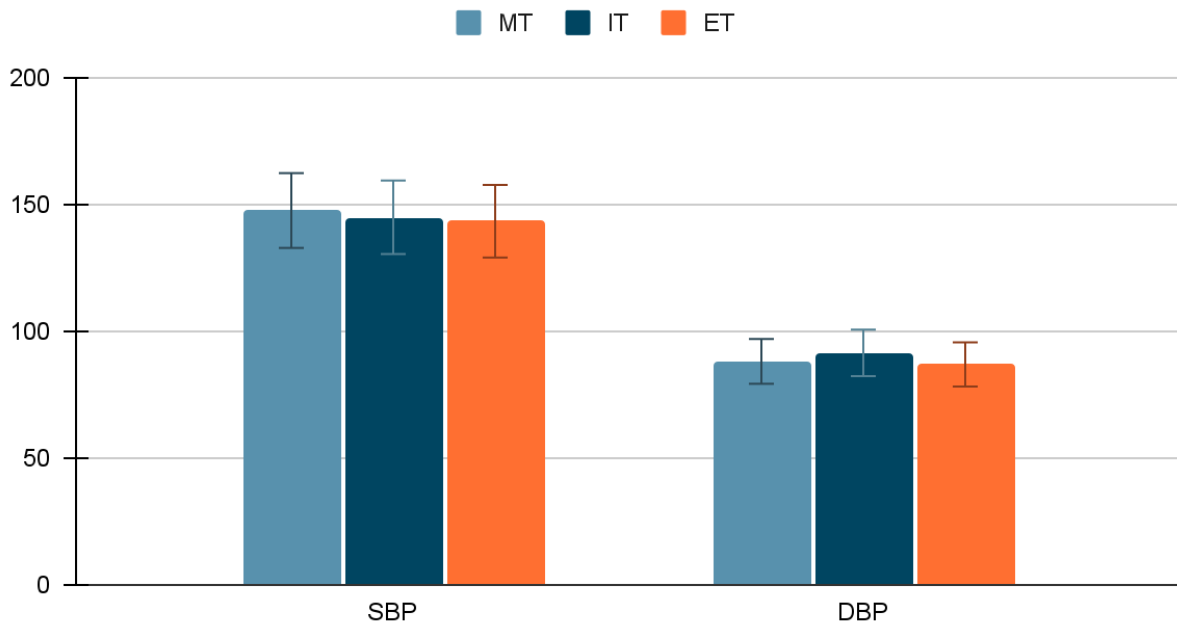
Chronotype and Body Composition



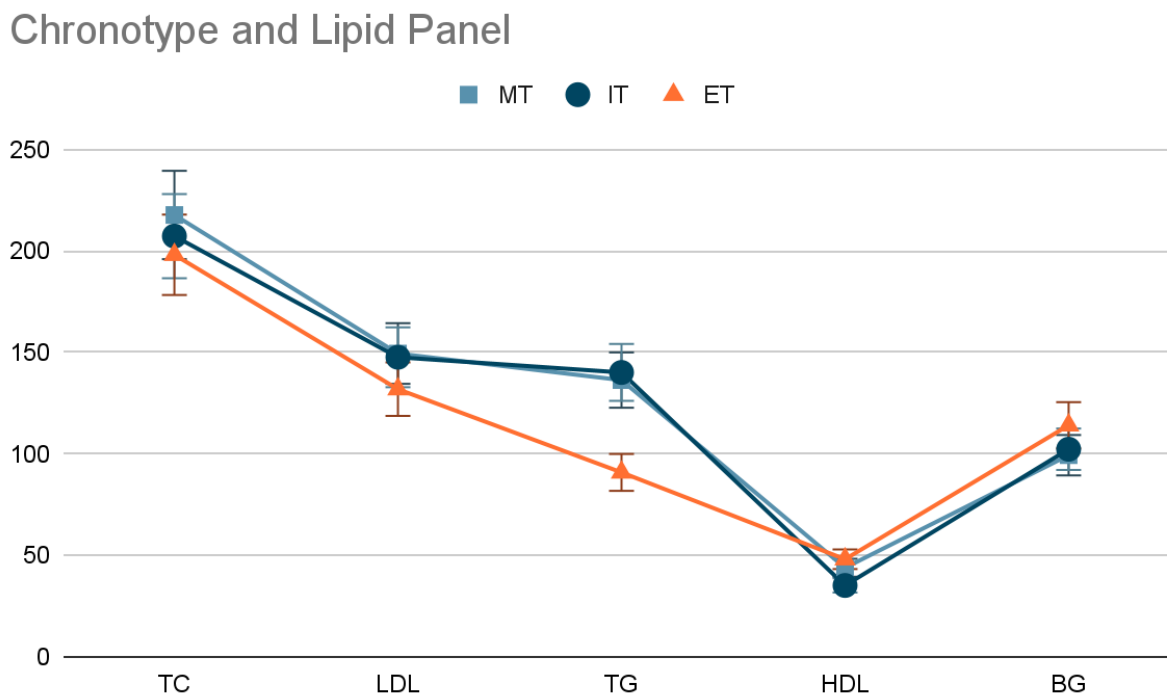
BMI: Body Mass Index, BF%: Body Fat Percentage, WC- Waist Circumference

Figure 2. Cardiovascular risk factor and the separate chronotype

Chronotype and Blood Pressure



SBP- Systolic Blood Pressure, DBP- Diastolic Blood Pressure

Figure 3. Blood Lipid Panel and the separate chronotype

TC- Total Cholesterol, LDL- Low Density Lipoprotein, TG- Triglycerides, HDL- High Density Lipoproteins, BG- Blood Glucose

The characteristics of the participants by chronotype are displayed in Table 2. There were no significant differences between chronotype groups on measures of cardiovascular disease risk. Alpha was set at $p < 0.05$.

Table 2. Chronotype of participants

Variable	<i>n</i>
Morning (MT)	11
Intermediate (IT)	16
Evening (ET)	09

CHAPTER 5

DISCUSSION

The purpose of this study is to investigate the relationship between chronotypes and cardiovascular disease risk factors among law enforcement officers. There were no significant findings between MT, IT, and ET chronotypes in the current population. This finding contrasts with previous established research. ETs have been shown to have an increased rate of obesity, hypertension, higher levels of triglycerides, and high-density lipoprotein cholesterol in comparison to MT. (Wong et al., 2015; Yu et al., 2015; Vera et al., 2018).

Descriptive Findings

Although no differences were found between chronotypes in cardiovascular risk factors, it was interesting to note that 50% of the participants were intermediate types, meaning they felt most alert and productive in the middle of the day, and then 25% of the officers were evening types. This study's findings were similar to previous articles, with participants commonly classified (greater 50%) as IT (Pacheco, 2022; Wei et al., 2019). Due to the nature of law enforcement, shifts work could potentially influence one's chronotype. Although previous literature indicates that chronotype is not easily changed, according to Timeshifter (n.d.), the nature of a shift work schedule can cause misalignment within their sleep-wake cycles to ensure their circadian clock can keep up. Further investigation into shift and chronotype is warranted to explore the influence of working within one's chronotype and working outside one chronotype and the potential increase risk of cardiovascular disease.

According to Gendron et al., (2019), in Quebec 48% of males and 56.7% of female officers were categorized as being at moderate or high risk of CVD. This study's descriptive

variables of law enforcement officer's health was consistent with previous research. The waist circumference average of this population for males is 103.27 cm while females were 105.42 cm, which is above the recommended limits 102 cm for males and 88 cm for females (Ross et al., 2020). Within the law enforcement population, our study was slightly above previous findings of 97.8 cm (Strauss et al., 2021). Both studies had a similar average age for police officers and made sure to exclude office personnel from these studies.

Obesity is a problem all across the US population. According to the CDC, as of 2017 the American population 20 years and older had a prevalence of obesity at 41.9% (Stierman et al., 2021). This study used BMI, body fat percentage and waist circumference to look at the predominance of obesity among these law enforcement officers. When figuring BMI this study had an average of 31.63 showing over 30 which is the value for falling in the obese category, according to the guidelines from the CDC (2022). In this study participants were shown to be 58.33% obese and 33% overweight. Compared to other studies that saw an average of participants in law enforcement were 48.7 % overweight and 31.7 % obese (Ander et al., 2016). Body fat percentage was another measure taken that showed overall obesity. Males had an average of 28.28 and females had an average of 45.27. Normal values for body fat percentage is 25% for male and 30% for females. In all three categories this study fell within the obese category overall.

Emergency responders, including police officers, have the second highest prevalence of hypertension (26%) among the different occupational groups (Hussain & Ajuwon 2020). This population had a 91.7% fall within the hypertensive categories. For this study the average blood pressure reading was 142/89 mmHg; which falls in the systolic stage 2 hypertension and diastolic stage 1 hypertension according to the American Heart Association (2023). Compared to other

police departments, this study follows the same trend of over half of the participants being hypertensive with each study coming from different locations, but all had similar average ages. Chauhan et al., (2022) found that 67.91% of the police officers in that study were hypertensive along with Yates et al., (2021) noted 60.5% were hypertensive with the participants.

Low density lipoprotein normative values for this study were 144.25 mg/dL, slightly over the recommended threshold of less than 110 mg/dL by the CDC (CDC, 2023). This was higher than the recent findings by Lockie et al. (2022) with an average officer's LDL at 101 mg/dL. Normative values for high density lipoprotein (HDL) were 41.08 mg/dL, which vary from other research showing an average of 55.15 mg/dL (Lockie, et al., 2022). The recommended HDL value for this is above 50 mg/dL, according to the CDC (2023). Interestingly, we found that police officers with the IT chronotype had an average of 37.06 mg/dL. At this present time, no known research has explored these variables. Blood levels are closely linked with exercise (Lamina, 2012), which lead to strategic promotion exercise as lifestyle intervention to mitigate the cardiovascular risk among this group. Additionally, the average total cholesterol for the participants in this study was 208.19 mg/dL indicating that most have high cholesterol, similarly linked to previous research from Hartley, (2011). According to Hartley (2011), the general population had an average of 193.2 mg/dL compared to the 200.8 mg/dL the police department had in values for total cholesterol. The range stated by the American College of Sports Medicine (ACSM) Guidelines for Exercise Testing and Prescription, 33.3% had "at-risk" levels and 31.6% were in the "high" category (Liguori et al., 2022). Elevated LDL, TC and depressed HDL suggest the need to address dyslipidemia in the population. Triglycerides were the only section from the lipid panel that fell within normal range of being less than 150 mg/dL. This study had an average of 126.67 and overall had an 8.3% that fell within the high range and 19.4% fell

within the borderline range for triglycerides. Blood glucose optimal values are below 110 mg/dL according to John Hopkins Medicine (2023). This study's average glucose level was 104.36 mg/dL which is higher when compared to other studies that looked at police officers and their lipid panel including blood glucose average of 90.5 mg/dL (Thayyil, 2012).

Limitations

This research, however, is subject to several limitations. The small sample size limits the findings and may not be applicable to a large population of law enforcement officers. The individuals who self-selected to participate in fitness may contribute to a selection biased population. The testing was offered only in the morning and the participants were allowed time-on-duty to attend, which could have influenced participation. Lastly, participants' compliance with pre testing protocols may have influenced testing results.

Practical Application

One way to ensure that the whole population understands and watches these values is to add the lipid panel into wellness checks but typically as of now it is only checked every 4 to 6 years (CDC, 2023). This is another assessment that can be done during a wellness check that can be administered once a year specifically for the department of law enforcement officers. While being proactive in implementing an exercise guideline for departments to follow can decrease the chance of these risk factors. Blood pressure checks can also be something added into a wellness check. This addition can educate them by making more officers aware of the symptoms of hypertension and giving new regulations as a department to enforce them to check their blood pressure to hopefully be proactive in diagnosing hypertension and work on getting it regulated.

Future Studies

Additional research is recommended to understand cardiovascular risk and law enforcement officers. Future research should focus on other factors that relate to chronotypes such as stress and sleep schedules, specifically in shift workers, by looking into how chronotype can be used to lower risk factors in law enforcement officers to make the job safer for everyone involved. Additionally, having a wide range sample to ensure that the entirety of a department is being analyzed to be able to provide the most accurate results and what can be done to decrease these risk factors in shift workers.

Conclusion

This study did not detect an influence of one's chronotype on cardiovascular risk among LEOs. However further investigations are warranted to help mitigate shift work for the study chronic types. It was highlighted that law enforcement officers in this southeastern region were at elevated risk of cardiovascular disease, shown with increases in high prevalence of cardiovascular risk factors, including metabolic syndrome, hypertension, hyperlipidemia, and a sedentary lifestyle. It is recommended to offer LEO targeted wellness programming to mitigate cardiovascular disease risk.

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Liguori, G., Feito, Y., Fountaine, C., & Roy, B. A. (2022). American College of Sports Medicine ACSM's *guidelines for exercise testing and prescription (Eleventh)*. Wolters Kluwer.

Loureiro, F., & Garcia-Marques, T. (2015, June 24). Morning or evening person? Which type are you? Self-assessment of Chronotype. *Personality and Individual Differences*. *86*, 168-171.

<https://www.sciencedirect.com/science/article/pii/S0191886915004031>.

MacKenzie-Shalders, KL., Lee, KW., Wright, C., Dulla, J., Tsoi, A., Orr, RM. (2022 Mar 23).

Dietary Intake in law enforcement personnel: occupation is an additional challenge for changing behavior. *Nutrients*. *14*(7); 1336. doi: 10.3390/nu14071336. PMID: 35405950; PMCID: PMC9002495.

Pacheco, Danielle. (2022, April 29). Chronotypes: definition, types, & effect on sleep. *Sleep Foundation*.

Ross, R., Neeland, I. J., Yamashita, S., Shai, I., Seidell, J., Magni, P., Santos, R. D., Arsenault, B., Cuevas, A., Hu, F. B., Griffin, B. A., Zambon, A., Barter, P., Fruchart, J.-C., Eckel, R. H., Matsuzawa, Y., & Després, J.-P. (2020, February). Waist circumference as a vital sign in clinical practice: a consensus statement from the IAS and ICCR working group on visceral obesity. *Nature reviews. Endocrinology*. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7027970>

Schneider, J., Farkova, E., & Bakstein, E. (2021, November 21). Human Chronotype: Comparison of questionnaires and wrist-worn actigraphy. *Taylor & Francis* 205-220. DOI:

10.1080/07420528.2021.1992418.

Stierman, B., Afful, J., Carroll, M., Chen, T., Davy, O., Fink, S., Fryar, C., Gu, Q., Hales, C.M., Hughes, J.P., Ostchega, Y., Storandt, R.J., & Akinbami, L.J.. (2021, June 14). National health and nutrition examination survey 2017–March 2020 prepandemic data files development of files and prevalence estimates for selected health outcomes. *National Health Statistics Reports*. 158. <http://dx.doi.org/10.15620/cdc:106273>.

Strauss, M., Foshag, P., Brzęk, A., Vollenberg, R., Jehn, U., Littwitz, H., Leischik, R. (2021 May 9). Cardiorespiratory fitness is associated with a reduced cardiovascular risk in occupational groups with different working conditions: a cross-sectional study among police officers and office workers. *Journal of Clinical Medicine*. 10(9), 2025. doi: 10.3390/jcm10092025. PMID: 34065102; PMCID: PMC8126004.

Thayyil, J., Jayakrishnan, T.T., Rajam M., Cherumanalil, J.M. (2012, Dec). Metabolic syndrome and other cardiovascular risk factors among police officers. *North American Journal of Medical Sciences*. 4(12), 630-5. doi: 10.4103/1947-2714.104313. PMID: 23272304; PMCID: PMC3530318.

Timeshifter®. (n.d.). *The science of shift work disorder*.

<https://www.timeshifter.com/shift-work/the-science-of-shift-work-disorder>

Vera, B., Dashti, H. S., Gomez-Abellan, P., Hernandez-Martinez, A. M., Esteban, A., Scheer, F., Saxena, R., & Garaulet, M. (2018). Modifiable lifestyle behaviors, but not a genetic risk score, associate with metabolic syndrome in evening chronotypes. *Scientific Reports*, 8(945), 1-11. <https://doi.org/10.1038/s41598-017-18268-z>

Wong, P. M., Hasler, B. P., Kamarck, T. W., Muldoon, M. F., & Manuck, S. B. (2015). Social jetlag, chronotype, and cardiometabolic risk. *The Journal of Clinical Endocrinology & Metabolism*, *100*(12), 4612-4620. <https://doi.org/10.1210/jc.2015-2923>

Wei, NS. & Praharaj, SK. (2019 Nov-Dec). Chronotypes and its association with psychological morbidity and childhood parasomnias. *Indian Journal of Psychiatry*. *61*(6):598-604. doi: 10.4103/psychiatry.IndianJPsychiatry_208_19. PMID: 31896866; PMCID: PMC6862985.

Yates, JD., Aldous, JWF., Bailey, DP., Chater, AM., Mitchell, ACS., Richards, JC. (2021, June 2). The prevalence and predictors of hypertension and the metabolic syndrome in police personnel. *International Journal of Environmental Research in Public Health*. *18*(13); 6728. doi: 10.3390/ijerph18136728. PMID: 34206524; PMCID: PMC8297085.

Yu, J. H., Yun, C. H., Ahn, J. H., Suh, S., Cho, H. J., Lee, S. K., Yoo, H. J., Seo, J. A., Kim, S. G., Choi, K. M., Baik, S. H., Choi, D. S., Shin, C., & Kim, N. H. (2015). Evening chronotype is associated with metabolic disorders and body composition in middle-aged adults. *The Journal of Clinical Endocrinology & Metabolism*, *100*(4), 1494-1502. <https://doi.org/10.1210/jc.2014-3754>.

Zimmerman, Franklin H. (2012 August). Cardiovascular disease and risk factors in law enforcement personnel: a comprehensive review. *Cardiology in Review*. *20*(4). p 159-166 doi: 10.1097/CRD.0b013e318248d631.

Appendix A

IRB Approval



RESEARCH INTEGRITY

Institutional Review Board (IRB)

Veazey Hall 3000
 PO Box 8005 • STATESBORO, GA 30460
 Phone: 912-478-5465
 Fax: 912-478-0719
IRB@GeorgiaSouthern.edu

To: Melton, Bridget; Klibert, Jeff; Grosicki, Greg; Cleveland, Richard

From: Eleanor Haynes, Director, Research Integrity

Date: 5/23/2022

Current Expiration Date: 2/28/2023

Original Approval Date: 3/12/2019

Subject: Status of Modification (#6) & Extension Request for Approval to Utilize Human Subjects in Research – Originally Approved by **Expedited Review**

After a review of your Extension & Modification Request for research project numbered **H19098**, and titled **“Physiological Profile of First Responders in Southeast United States,”** it appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable. You are authorized to enroll up to a maximum of 500 subjects.

Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your extension and modification.

Modification description:

- The addition of Richard Cleveland as a Co-PI for this study has been approved.
- The addition of two surveys to this study has been approved.
- The increase in the number of study participants has been approved.
- The addition of a finger prick protocol to this study to assess cardiovascular risk has been approved.

Please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to notify the IRB Coordinator, so your file may be closed.

Appendix B

Annotated Bibliography

Obesity

Anderson, A. A., Yoo, H., & Franke, W. D. (2016). Associations of physical activity and obesity with the risk of developing the metabolic syndrome in law enforcement officers. *Journal of Occupational and Environmental Medicine*, 58(9), 946–951.

<https://www.jstor.org/stable/48501709>.

Participants were sworn LEOs of the Iowa Department of Public Safety, who were recruited during their annual medical evaluation; 492 agreed to participate. The purpose of this study was to examine the associations of physical activity and body mass index (BMI) with the metabolic syndrome (MetS) in police officers. Self-reported physical activity, MetS, and a modified MetS were assessed in 448 officers.1. Of the 448 LEOs, 97% were Caucasian and 94% were male. Among the total participants, 27.5% had metabolic syndrome. Almost half and one-third of the participants were classified as overweight (48.7%) or obese (31.7%), respectively. This study is used to compare obesity rates of the Iowa police officer population to the one used for this study.

Centers for Disease Control and Prevention. (2022, June 3). *About adult BMI*.

https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html.

This article is from the CDC and gives the BMI categories and explains how it is calculated. This is used to divide participants into groups based on BMI.

MacKenzie-Shalders, KL., Lee, KW., Wright, C., Dulla, J., Tsoi, A., Orr, RM. (2022 Mar 23).

Dietary Intake in law enforcement personnel: occupation is an additional challenge for changing

behavior. *Nutrients*. 14(7); 1336. doi: 10.3390/nu14071336. PMID: 35405950; PMCID: PMC9002495.

This study looked at law enforcement officers and their daily diet. They then took into consideration if the officers were willing to change their diet and the different reasons why they could or could not and if the answers varied by demographics. Overall this was used to show that Dietary intake in law enforcement officers is impacted by occupational considerations, including busy schedules, long working hours, inconsistent meal breaks, tiredness, and shift work but it is not dependent on demographics.

Ross, R., Neeland, I. J., Yamashita, S., Shai, I., Seidell, J., Magni, P., Santos, R. D., Arsenault, B., Cuevas, A., Hu, F. B., Griffin, B. A., Zambon, A., Barter, P., Fruchart, J.-C., Eckel, R. H., Matsuzawa, Y., & Després, J.-P. (2020, February). Waist circumference as a vital sign in clinical practice: a consensus statement from the IAS and ICCR working group on visceral obesity. *Nature reviews. Endocrinology*. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7027970>.

This article connects waist circumference to obesity and gives the normal range values for waist circumference which is how it is used in this study.

Stierman, B., Afful, J., Carroll, M., Chen, T., Davy, O., Fink, S., Fryar, C., Gu, Q., Hales, C.M., Hughes, J.P., Ostchega, Y., Storandt, R.J., & Akinbami, L.J.. (2021, June 14). National health and nutrition examination survey 2017–March 2020 prepandemic data files development of files and prevalence estimates for selected health outcomes. *National Health Statistics Reports*. 158. <http://dx.doi.org/10.15620/cdc:106273>.

This study was done to look at the health and nutrition at a national level pre pandemic. This study showed that adults over the age of 20 had a 41.9% of being obese which was used to

compare to the law enforcement officer population.

Strauss, M., Foshag, P., Brzęk, A., Vollenberg, R., Jehn, U., Littwitz, H., Leischik, R. (2021 May 9). Cardiorespiratory fitness is associated with a reduced cardiovascular risk in occupational groups with different working conditions: a cross-sectional study among police officers and office workers. *Journal of Clinical Medicine*. 10(9), 2025. doi: 10.3390/jcm10092025. PMID: 34065102; PMCID: PMC8126004.

This study aimed to evaluate the effects of cardiorespiratory fitness on reducing cardiovascular risk factors in these occupational groups. This cross-sectional study enrolled 101 male participants (55 police officers and 46 office workers) in Germany. This study was used to compare waist circumference of the different police departments participants.

Hypertension

American Heart Association (2023, February 2). *Understanding blood pressure readings*.

<https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings>.

This page is an outline of blood pressure ranges according to the American heart association.

Chauhan, VS., Bansal, M., Sharma, V., Gupta, R. (2022 Jul-Sep). Prevalence and risk factors of hypertension among police personnel of district gwalior- a cross sectional study. *Indian Journal of Community Medicine*. 47(3):379-385. doi: 10.4103/ijcm.ijcm_1154_21. Epub 2022 Oct 10. PMID: 36438512; PMCID: PMC9693942.

This study concludes that Hypertension is an emerging public health problem due to its high prevalence and association with cardiovascular and overall morbidity and mortality. Police personnel are a special occupational group with exposure to violence and stress at work, which affects their health directly and indirectly. This is a cross-sectional study that was conducted to

find out the prevalence of hypertension and its relation with respect to police duty profile along with other risk factors among the police personnel of the Gwalior district stationed at various police stations. In total, 402 police personnel were included in the study. The findings of our study, 273 (67.91%) participants came out to be hypertensive; among them. This is used to compare to this study's participants and their blood pressure levels.

Fuchs, F. D., & Whelton, P. K. (2020). High blood pressure and cardiovascular disease. *Hypertension*, 75(2), 285–292. <https://doi.org/10.1161/hypertensionaha.119.14240>.

High blood pressure (BP), cigarette smoking, diabetes mellitus, and lipid abnormalities are major modifiable risk factors for cardiovascular disease (CVD). Among these, high BP is associated with the strongest evidence for causation and has a high prevalence of exposure. This is used to link high blood pressure to CVD in this study.

Hussain OJ, Ajuwon AJ. (2020 Dec). Prevalence, knowledge and preventative practices against hypertension among police officers in Ibadan. *Annals of Ibadan Postgraduate Medicine*. 18(2); 114-121. PMID: 34421453; PMCID: PMC8369398.

This study is looking into the police officers population and explaining how occupation can have an effect on hypertension. A total of 170 police officers participated in the study.

Abdominal circumference and blood pressure were measured among study participants. Mean age of respondents was 36.7±8.4 years; more than half (64.7%) were males. The prevalence of abdominal obesity and hypertension were 51.7% and 17.5% respectively. This is used to compare hypertension between studies.

Liguori, G., Feito, Y., Fountaine, C., & Roy, B. A. (2022). American College of Sports Medicine ACSM's *guidelines for exercise testing and prescription (Eleventh)*. Wolters Kluwer.

ACSM guidelines book where blood pressure levels testing procedures were pulled from for data collection.

McMahon, D., Burch, J., Youngstedt, S., Wirth, M., Hardin, J., Hurley, T., Blair, S., Hand, G., Shook, R., Drenowatz, C., Burgess, S. & Hebert, J. (2019). Relationships between chronotype, social jetlag, sleep, obesity and blood pressure in healthy young adults, *Chronobiology International*, 36(4), 493-509.

Sleep disturbances, chronotype and social jetlag (SJL) have been associated with increased risks for major chronic diseases that take decades to develop, such as obesity, metabolic syndrome and cardiovascular disease. This study examined chronotype, SJL and poor sleep in relation to both obesity and elevated blood pressure among healthy young adults. The results from this study among healthy young adults suggest that poor sleep among morning types may be more strongly associated with obesity and elevated blood pressure relative to those with an intermediate (neutral) chronotype. This is used to compare blood pressure among chronotypes.

Yates, JD., Aldous, JWF., Bailey, DP., Chater, AM., Mitchell, ACS., Richards, JC. (2021, June 2). The prevalence and predictors of hypertension and the metabolic syndrome in police personnel. *International Journal of Environmental Research in Public Health*. 18(13); 6728. doi: 10.3390/ijerph18136728. PMID: 34206524; PMCID: PMC8297085.

This study looked at both police officers and non operational police. This was used to compare hypertension among law enforcement officers and the civilians that work around them. This was compared to the population of our study that had similar demographics.

Dyslipidemia

Centers for Disease Control and Prevention. (2023, March 20). *About cholesterol*.

<https://www.cdc.gov/cholesterol/about.htm>.

This article breaks down the categories for cholesterol. This was used to categorize participants.

Centers for Disease Control and Prevention. (2023, March 20). *High cholesterol facts*.

<https://www.cdc.gov/cholesterol/facts.htm>.

This article gives information about cholesterol levels and this was used to compare the police departments to civilians in this study.

Guisto, M. (2017, March 15). Understanding the CHOLESTECH LDX system. *Center For Fitness and Wellness*.

<https://sites.psu.edu/kinescfw/health-education/our-assessments/understanding-the-cholestech-lx-system/>

Cholestech is a reliable way to measure cholesterol, HDL, LDL, triglycerides, and glucose levels. This system is a convenient, relatively cheap way to accurately measure important health aspects. This was the machine and testing procedures used for the blood lipid panel.

Hartley TA., Burchfiel CM., Fekedulegn D., Andrew ME., Violanti JM. (2011). Health disparities in police officers: comparisons to the U.S. general population. *International Journal of Emergency Mental Health*. 13(4); 211-20. PMID: 22900455; PMCID: PMC4734372.

Based in the US this study compared total cholesterol levels from a police department and the general public which we compared to our participants that had a similar mean age.

Lamina, S., Okoye, GC. (2012 Jan-Mar). Therapeutic effect of a moderate intensity interval training program on the lipid profile in men with hypertension: a randomized controlled trial. *Nigerian Journal of Clinical Practice*. 15(1):42-7. doi: 10.4103/1119-3077.94096. PMID: 22437088.

This study looked at ways to lower the values in the lipid profile by changing lifestyle factors

such as training programs.

Lockie, R. G., Orr, R. M., & Dawes, J. J. (2022). Fit (and healthy) for duty: blood lipid profiles and physical fitness test relationships from police officers in a health and wellness program.

International Journal of Environmental Research and Public Health, 19(9), 5408.

This study was used to compare blood lipid profiles from these participants in the police department to our participants. Looking into the difference in departments and their overall lipid panel results.

Johns Hopkins Medicine. (2020, December 4). *Lipid panel*.

<https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/lipid-panel>.

Used to outline the categorization of blood lipid panels results.

Thayyil, J., Jayakrishnan, T.T., Rajam M., Cherumanalil, J.M. (2012, Dec). Metabolic syndrome and other cardiovascular risk factors among police officers. *North American Journal of Medical Sciences*. 4(12), 630-5. doi: 10.4103/1947-2714.104313. PMID: 23272304; PMCID:

PMC3530318.

This is a cross sectional study that looked into metabolic syndrome that involved 900 police officers. MS was observed in 16.8% of the study population. High blood pressure and hyper-triglyceridemia were the commonest abnormalities. The prevalence of other cardiovascular risk factors were high body mass index (65.6%), and hypertension (37.7%). We used more specifically the blood glucose values to compare the [participants of both studies.

Vera, B., Dashti, H. S., Gomez-Abellan, P., Hernandez-Martinez, A. M., Esteban, A., Scheer, F., Saxena, R., & Garaulet, M. (2018). Modifiable lifestyle behaviors, but not a genetic risk score, associate with metabolic syndrome in evening chronotypes. *Scientific Reports*, 8(945), 1-11.

<https://doi.org/10.1038/s41598-017-18268-z>.

This study was conducted to focus more on the metabolic syndrome association specifically in evening type. Evening types showed an increase in metabolic outcomes in components of the metabolic syndrome including higher BMI, higher triglycerides, and lower HDL-cholesterol.

This was used to compare values across the different chronotypes.

Yu, J. H., Yun, C. H., Ahn, J. H., Suh, S., Cho, H. J., Lee, S. K., Yoo, H. J., Seo, J. A., Kim, S. G., Choi, K. M., Baik, S. H., Choi, D. S., Shin, C., & Kim, N. H. (2015). Evening chronotype is associated with metabolic disorders and body composition in middle-aged adults. *The Journal of Clinical Endocrinology & Metabolism*, *100*(4), 1494-1502.

<https://doi.org/10.1210/jc.2014-3754>.

This study is looking at the evening type of chronotype and if they have a higher risk of having these metabolic disorders. It is used in this study to show that ET was independently associated with metabolic syndrome.

Wong, P. M., Hasler, B. P., Kamarck, T. W., Muldoon, M. F., & Manuck, S. B. (2015). Social jetlag, chronotype, and cardiometabolic risk. *The Journal of Clinical Endocrinology & Metabolism*, *100*(12), 4612-4620. <https://doi.org/10.1210/jc.2015-2923>.

This study looked into the general population and how chronotype can affect cardiometabolic risk. It is used in this study to point out that ET has a higher risk of an increase in these risk factors when compared to MT.

Chronotype

Garbarino, S., Guglielmi, O., Puntoni, M., Bragazzi, N. L., & Magnavita, N. (2019). Sleep quality among police officers: implications and insights from a systematic review and

meta-analysis of the literature. *International Journal of Environmental Research and Public Health*, 16(5) 1-15.

This study was done to look at the sleep quality among police officers. It shows police officers who work "out of phase" with reference to their chronotype and how it can make the job more stressful and dangerous if they are not getting enough sleep. I will use this to compare with the data we have collected from the police department here.

Hittle BM, Gillespie GL. (2018, Nov 21). Identifying shift worker chronotype: implications for health. *Industrial Health*. 56(6):512-523. doi: 10.2486/indhealth.2018-0018. Epub 2018 July 3. PMID: 29973467; PMCID: PMC6258747.

Shift workers are at higher risk for developing serious health issues due to short sleep. One cause of short sleep is circadian misalignment. Although circadian rhythms are strongly driven by the light/dark cycle, humans have individualized sleep time preferences named chronotypes that's based on genetics, development, and external influences. This is used to link the health issues that can lead to CVD to the messed up sleep cycle of shift workers.

Juda, M., Vetter, C., & Roenneberg, T. (2013, April 19). The Munich ChronoType Questionnaire for Shift-Workers (MCTQShift). *Sage Journals*. 28(2), 130–140.

This article goes into detail about the MCTQShift questionnaire. This is an extended version of the MCTQ questionnaire that takes into consideration shift work hours rather than standard hours. I will use this information to relate the studies used to the police department that we collected data from.

Danielsson, K., Sakarya, A. & Jansson-Fröjmark, M. (2019). The Reduced Morningness–Eveningness Questionnaire: Psychometric properties and related factors in a young Swedish population, *Chronobiology International*, 36(4), 530-540.

This article explains the breakdown of the scoring for the questionnaire taken by participants and was used to score their answers.

Kervezee, L., Gonzales-Aste, F., Boudreau, P., & Boivin, D. (2021, April). The relationship between chronotype and sleep behavior during rotating shift work: a field study, *Sleep*, 44(4). doi: 10.1093/sleep/zsaa225. PMID: 33538307.

The objective of this study was to look at the effect of chronotype, shift type, and their interaction on actigraphy-based sleep behavior in 74 police officers involved in rotating shift work throughout a 28- to 35-day work cycle consisting of morning, evening, and night shifts. This study advances the understanding of the relationship between chronotype and sleep in rotating shift workers and supports the inclusion of work schedules that take into account chronobiological types in the workers.

Loef, B., Baarle, D. V., van der Beek, A. J., Beekhof, P. K., van Kerkhof, L. W., & Proper, K. I. (2019). The association between exposure to different aspects of shift work and metabolic risk factors in health care workers, and the role of chronotype. *PLoS One*, 14(2), 1-14. <https://doi.org/10.1371/journal.pone.0211557>.

Shift work has been linked to cardio-metabolic diseases. This study examined the relationship between current shift work status, how often and length of night shift work, chronotype, and metabolic risk factors in a population of health care workers. This relates back and is linked to sleep loss due to shift work.

Loureiro, F., & Garcia-Marques, T. (2015, June 24). Morning or evening person? Which type are you? Self-assessment of Chronotype. *Personality and Individual Differences*. 86, 168-171. <https://www.sciencedirect.com/science/article/pii/S0191886915004031>.

This article explains the difference between the chronotypes and goes over some of the tests used to determine the chronotype a person is. I will use this information to show the different characteristics of each chronotype and how the questionnaires used show the different types.

Pacheco, Danielle. (2022, April 29). Chronotypes: definition, types, & effect on sleep. *Sleep Foundation*.

This article will be used to have the chronotype definition and the different types of chronotypes.

Schneider, J., Farkova, E., & Bakstein, E. (2021, November 21). Human Chronotype: Comparison of questionnaires and wrist-worn actigraphy. *Taylor & Francis* 205-220. DOI: [10.1080/07420528.2021.1992418](https://doi.org/10.1080/07420528.2021.1992418).

This study used different questionnaires and actigraphy to compare and distinguish between the different chronotypes. I will use this to explain the types of chronotypes.

Timeshifter®. (n.d.). *The science of shift work disorder*.

<https://www.timeshifter.com/shift-work/the-science-of-shift-work-disorder>.

This article helps explain ways to alter your chronotype by adjusting to a schedule but explaining that it can't be forever changed. This helps better explain why it works best to work with your chronotype or why people think they are starting over getting back into a work schedule after having a few days off.

Wei, NS. & Praharaj, SK. (2019 Nov-Dec). Chronotypes and its association with psychological morbidity and childhood parasomnias. *Indian Journal of Psychiatry*. 61(6):598-604. doi: 10.4103/psychiatry.IndianJPsychiatry_208_19. PMID: 31896866; PMCID: PMC6862985.

This study shows that Intermediate chronotype was the most common, seen in 87 (58%) college students, followed by evening type in 34 (22.7%). This falls inline with the participants we used showing that there is more IT than any other group.

CVD

Gendron, P., Lajoie, C., Laurencelle, L., & Trudeau, F. (2019). Cardiovascular health profile among Québec male and female police officers, *Archives of Environmental & Occupational Health*, 74(6), 331-340, DOI: [10.1080/19338244.2018.1472063](https://doi.org/10.1080/19338244.2018.1472063).

This study wanted to look at the cardiovascular health profiles of police officers in Quebec. Everything for this study was accumulated by questionnaires. This was used to compare overall cardiovascular health in police officers from this study to ours.

Zimmerman, Franklin H. (2012 August). Cardiovascular disease and risk factors in law enforcement personnel: a comprehensive review. *Cardiology in Review*. 20(4). p 159-166 doi: 10.1097/CRD.0b013e318248d631.

This study looks at the fact that law enforcement officers have a high stress occupation which can lead to an increase in CVD risk factors.