**UNITED STATES DISTRICT COURT**

**NORTHERN DISTRICT OF CALIFORNIA**

**OAKLAND DIVISION**

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| TODD ASHKER, et al.,<br><br>Plaintiffs,<br><br>v.<br><br>GOVERNOR OF THE STATE OF CALIFORNIA, et. al.,<br><br>Defendants. | Case No.: 4:09-cv-05796-CW<br><br>CLASS ACTION<br><br>Judge: Honorable Claudia Wilken |

# EXPERT REPORT OF LOUISE C. HAWKLEY

1) I am a Senior Research Scientist with NORC at the University of Chicago, Chicago, Illinois. My primary responsibilities are to initiate, implement, and manage scientific research projects and to publish quantitative, statistically-based social science research. Trained at the Ohio State University as a psychologist with a psychophysiology specialty, I have been a Research Associate and then Research Scientist since 2001, first at the University of Chicago and, since 2013, at NORC. My areas of expertise include social psychology/psychophysiology and quantitative psychology, including the statistical and quantitative analysis of social science data. I am an expert in social isolation and loneliness and their effects on physical and mental health and well-being. I have published over 100 articles and chapters in peer-reviewed professional journals and books. My resume, including a list of my publications, is attached as Exhibit A.

2) I was asked by Plaintiffs' counsel to provide an opinion on whether confinement of an individual for a prolonged period of time in the Pelican Bay Security Housing Unit (SHU) in comparison with prolonged confinement in the Pelican Bay General Population (GP) – by more than ten years in this case - would lead that individual to face an increased risk of hypertension and early mortality.

3) I am being paid $150 per hour plus all expenses for my work on this matter.

4) I have never testified as an expert in court before.

5) I had access to the following material when conducting my analyses:

   a. Data files, provided by Plaintiffs' counsel, listing all prisoners who, as of November 2014, were receiving care for at least one chronic health condition. Data include information on prisoners' dates of birth, mental illness diagnosis, physical disabilities, learning disabilities, and chronic health conditions, including

hypertension, as well as clinical risk classification (low, medium, high). Data were organized by prisoners' CDCR number and security level identified as general population or SHU population.

b. Data files, provided by Plaintiffs' counsel, listing all prisoners who, as of November 2014, had been imprisoned for at least 10 years in either the GP or the SHU[1]. Data were organized by prisoners' CDCR number and security level identified as general population or SHU population.

c. Stata version 13, a widely used and recognized software system for data management and statistical analysis of data.

6) My opinion, set forth below, is based upon my experience and qualifications as a social scientist and statistical data analyst with extensive experience in statistical analysis. I reserve the right to supplement or amend this report if additional materials become available to me.

7) Using the data available to me, I performed two sets of analyses: (i) analyses that examined whether hypertension prevalence differed between the GP and SHU populations for the entire data set ; (ii) analyses that examined whether hypertension prevalence differed between the GP and SHU populations in only those prisoners who had been imprisoned for more than 10 years.

**SUMMARY**

My research and the research of many other scholars definitively demonstrates that, in general, people who are socially isolated and are lonely have a significantly greater risk of hypertension, cardiovascular illnesses and early mortality from heart attacks or other

[1] Data consisted of current SHU prisoners who had been in the SHU for 10 years or more, and GP prisoners who had been in prison for 10 years or more and were now in the general population.

cardiovascular illnesses. For purposes of this report Plaintiffs' counsel asked me to assume that prisoners confined in the SHU are confined to their cell by themselves for 22-23 hours a day, had no group recreation or group congregation with other prisoners, receive few if any phone calls, and have no contact visits. I was also asked by Plaintiffs' counsel to assume for purposes of my analysis that prisoners confined in the Pelican Bay General Population also faced very restrictive conditions but had limited (2 hours per day) group recreation, contact visits and more phone calls. Based on my and others' research, I conclude that individuals confined in the SHU conditions for a prolonged period of time face an objectively very high degree of social isolation and I predict that they would also subjectively experience and report a very high level of social loneliness. Indeed, I was provided with the results of a survey taken by Prof. Craig Haney using the UCLA Loneliness Scale, which I also use in my research, which shows an astoundingly high degree of loneliness reported by the SHU prisoners. Based on this survey and the objective conditions of isolation, my research, and that of many other researchers, would predict a higher risk of hypertension for prisoners in the SHU than prisoners in the general prison population who are subject to many of the same conditions and routines but have a lesser degree of social isolation.

I tested the prediction that placement in the isolating conditions of the SHU as opposed to similarly restrictive but otherwise less isolating conditions in a high security general population unit would lead to an increased risk of hypertension, by evaluating data provided to Plaintiffs' counsel by the California prison authorities and given by Plaintiffs' counsel to me. My analysis of these data was consistent with the overall research on the effect of social isolation. While I will set forth the analysis of the data more specifically and in detail below, my general

conclusion is that an analysis of the data provided to me demonstrates that a person placed in the SHU as opposed to the General Population has a significantly greater chance of developing hypertension, particularly at a relatively young age, with the associated serious health risks of deadly heart disease associated with hypertension. The data of Pelican Bay SHU and GP prisoners thus supports the general research in non-prison populations showing that social isolation and loneliness contribute to increased mortality due to cardiovascular illnesses.

**BACKGROUND**

Social isolation is bad for health and shortens life. A recent review and meta-analysis of 148 studies representing more than 308,000 individuals found that smaller social networks, fewer social contacts, less frequent social activities, lack of a spouse, or simply feeling isolated or lonely increases the risk of mortality. Conversely, active social relationships were associated with significantly longer life expectancy, and even longer life expectancy for those with active relationships across all of the foregoing aspects of social integration[2]. In comparison to traditional risk factors, a relative lack of social relationships exerted a risk comparable to if not greater than what has been reported for smoking, alcohol consumption, physical inactivity, and overweight[3]. My own research has shown that feelings of loneliness predict mortality in adults over the age of 50, even after adjusting for physical inactivity and smoking. At least four additional studies conducted since then have replicated these effects, with social isolation or

[2] Holt-Lunstad J, Smith TB, Layton JB (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Med 7(7)*, e1000316

[3] Ibid.; House JS, Landis KR, Umberson D (1988) Social relationships and health. *Science, 241,* 540–545

loneliness predicting mortality in the US and the United Kingdom[4]. One of these was an especially large study that estimated the risk for mortality associated with social isolation in a representative sample of 16,849 noninstitutionalized civilian US population, and explicitly compared this risk with that of traditional clinical risk factors exhibited by the adults in the study[5]. Social isolation was quantified by summing the number of domains in which adults were lacking social integration: being unmarried, having infrequent social contact, participating infrequently in religious activities, and lacking club or organization affiliations. The results were clear: the greater the degree of social isolation, the worse the survival rate. Moreover, the mortality risk associated with social isolation was similar to the risk associated with smoking and greater than the risk associated with obesity, high blood pressure, and high cholesterol. In sum, research to date shows a robust association between social isolation and mortality that is at least as large as traditional risk factors that receive much clinical and epidemiological attention.

Loneliness is also associated with disruptions in the regulation of physiological systems of the body. For instance, the "stress" system responsible for regulating cortisol, a hormone necessary to mobilize the body's energy resources, shows evidence of dysregulation in lonely

[4] Holwerda TJ, Beekman AT, Deeg DJ, et al. (2012). Increased risk of mortality associated with social isolation in older men: only when feeling lonely? Results from the Amsterdam Study of the Elderly (AMSTEL). *Psychological Medicine, 42*, 843–53; Pantell, M., Rehkopf, D., Jutte, D., Syme, L., Balmes, J., & Adler, N. (2013). Social isolation: A predictor of mortality comparable to traditional clinical risk factors. *American Journal of Public Health, 103*, 2056-2062; Perissinotto, C. M., Cenzer, I. S., & Covinsky, K. E. (2012). Loneliness in older persons: A predictor of functional decline and death. *Archives of Internal Medicine, 172*, 1078-1083; Steptoe, A., Shankar, A., Demakakos, P., & Wardle, J. (2013). Social isolation, loneliness, and all-cause mortality in older men and women. *PNAS, 110*, 5797-5801.

[5] Pantell, M., Rehkopf, D., Jutte, D., Syme, L., Balmes, J., & Adler, N. (2013). Social isolation: A predictor of mortality comparable to traditional clinical risk factors. *American Journal of Public Health, 103*, 2056-2062.

relative to nonlonely individuals[6]. My research has shown that lonelier individuals exhibit higher early morning and late night levels of circulating cortisol, and larger increases in salivary cortisol during the first 30 minutes after awakening. Other research consistent with these findings has shown that cortisol levels, which typically decrease over the weekend relative to working days, are perpetually higher in lonely than nonlonely individuals, and do not decrease on weekend days[7]. Lonelier individuals also show evidence of a phenomenon known as glucocorticoid insensitivity, however. My and others' research has shown that the same amount of cortisol may not be as effective in lonely as in nonlonely individuals[8]. This is particularly important for the regulation of inflammation in the body. Cortisol is a potent anti-inflammatory substance, and to the extent it is relatively ineffective in dampening inflammation in the body, risk is increased for inflammatory diseases such as hypertension, cardiac diseases, stroke, and diabetes.

Research suggests that the cardiovascular system is especially vulnerable to the impact of social isolation and loneliness. In my study of middle- and older-age adults, loneliness was associated with significantly higher blood pressure at study onset, and with larger increases in blood pressure over a 4-year follow-up, such that at the end of the follow-up period, people with the most intense feelings of loneliness had systolic blood pressure (SBP) readings that

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[6] Pressman, S. D., Cohen, S., Miller, G. E., Barkin, A., Rabin, B. S., & Treanor, J. J. (2005). Loneliness, social network size, and immune response to influenza vaccination in college freshmen. *Health Psychology, 24*, 297-306; Adam, E. K., Hawkley, L. C., Kudielka, B. M., & Cacioppo, J. T. (2006). Day-to-day dynamics of experience-cortisol associations in a population-based sample of older adults. *PNAS, 103*, 17058-17063; Steptoe A, Owen N, Kunz-Ebrecht SR, Brydon L (2004). Loneliness and neuroendocrine, cardiovascular, and inflammatory stress responses in middle-aged men and women. *Psychoneuroendocrinology, 29(5)*, 593–611.

[7] Okamura, H., Tsuda, A., & Matsuishi, T. (2011). The relationship between perceived loneliness and cortisol awakening responses on work days and weekends. *Japanese Psychological Research, 53*, 113-120.

[8] Hawkley, L. C., Cole, S. W., Capitanio, J. P., Norman, G. J., & Cacioppo, J. T. (2012). Effects of social isolation on glucocorticoid regulation in social mammals. *Hormones & Behavior, 62,* 314-323; Cole SW. (2008). Social regulation of leukocyte homeostasis: The role of glucocorticoid sensitivity. *Brain Behav Immun, 22,* 1049–1055.

were as much as 14 points higher than the least lonely individuals[9]. The extent of this increase can move a person from normotension to a diagnosis of hypertension in a period of five years (e.g., from an SBP of 130 to an SBP of 144, above the hypertension criterion of 140 and more). In other words, faster rates of increases in SBP translate into higher rates of clinical hypertension at a younger age.

The development of hypertension is medically important because hypertension damages blood vessels and the heart, thereby increasing risk for serious cardiovascular health problems. Indeed, others' research has shown that social isolation and loneliness are associated not only with elevated blood pressure but also with other cardiovascular conditions, including heart disease and stroke[10]. In addition, although most research has examined the association between social isolation and all-cause mortality, some research has examined and found an association between social isolation and cardiovascular mortality in particular[11]. Thus, to the extent that social isolation increases risk for hypertension, it also increases risk for serious cardiovascular disease and mortality. Moreover, the earlier the onset of hypertension, the earlier the development of serious cardiovascular conditions and subsequent mortality.

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[9] Hawkley, L. C., Thisted, R. A., Masi, C. M., & Cacioppo, J. T. (2010). Loneliness predicts increased blood pressure: Five-year cross-lagged analyses in middle-aged and older adults. *Psychology & Aging, 25*, 132-141.

[10] Thurston RC, Kubzansky LD. Women, loneliness, and incident coronary heart disease. Psychosom Med. 2009; 71: 836–842; Tomaka, J., Thompson, S., & Palacios, R. (2006). The relation of social isolation, loneliness, and social support to disease outcomes among the elderly. *Journal of Aging and Health, 18*, 359-384.

[11] Eng, P. M., Rimm, E. B., Fitzmaurice, G., & Kawachi, I. (2002). Social ties and change in social ties in relation to subsequent total and cause-specific mortality and coronary heart disease incidence in men. *American Journal of Epidemiology, 155*, 700-709.

**PREDICTION**

Loneliness is not synonymous with objective social isolation, and the correlation between the two is typically moderate in size. However, loneliness is strongly associated with objective social isolation in circumstances where one has limited choice in when and with whom to interact (e.g., placement in nursing homes for the elderly). Imprisonment that entails severe restrictions on social contact with the outside world and severely restricts the social interactions between prisoners would be expected to result in intense feelings of loneliness. Support for this prediction was provided by results included in the section of Dr. Craig Haney's report forwarded to me by Plaintiffs' counsel in which Dr. Craig Haney sets forth his use of the UCLA Loneliness Scale in two groups of long-term PBSP prisoners – those in the SHU and those in the general population – and the results that he found. In the American adult population, loneliness levels range from 30-40 (on a scale that ranges from 20-80). In the prisoners Dr. Haney interviewed, loneliness levels averaged 41.6 for prisoners in the general population and an astounding 54.9 for prisoners in the SHU. Based on my research, I would therefore predict that hypertension rates in the SHU are higher than in the general prison population (GP). However, because both groups are relatively socially isolated and the GP prisoners also reported a high degree of loneliness, although less than the SHU prisoners, the comparison of hypertension rates in these two populations is likely a conservative estimate of the effect of social isolation *per se*, and is instead an estimate of the effect of extreme social isolation over and above the effect of the relative social isolation experienced in the GP.

**DATA SOURCE AND ANALYTIC STRATEGY**

In February of 2015, Plaintiffs' counsel forwarded to me four data files that were provided by the California Department of Corrections and Rehabilitation (CDCR). The first two data files listed all prisoners who were receiving care for at least one chronic condition (1) in the General Population (GP; 283 prisoners) and (2) in the Security Housing Unit (SHU; 343 prisoners). The file also provided their dates of birth, illness diagnosis, whether they have a physical disability, whether they have a learning disability, and variables whether they have any of several chronic health conditions, including hypertension. The second two data files listed all prisoners who had been imprisoned for at least 10 years, regardless of their health status, (1) in the GP (315 prisoners), and (2) in the SHU (246 prisoners).

I used statistical software, Stata (version 13, StataCorp, 2013), to import and combine the four data files into a single file, aligned on prisoner identification number (i.e., CDCR number) that was then used to prepare the data for analyses. The final file contained data for 1,025 prisoners. The prisoners ranged in age from 27 to 71 years old. Preliminary analyses revealed that the SHU population is significantly older on average than the GP population (44.5 vs. 37.6 years).

Analyses proceeded in two steps. First, I examined whether hypertension prevalence differed between the GP and SHU populations in the total sample for which I had data. Second, I focused on matching the two populations more closely and re-examined hypertension prevalence in only those prisoners who had been imprisoned for more than 10 years in the GP or the SHU. Because age and some chronic health conditions increase risk for hypertension, I statistically adjusted for age and health conditions that have been associated with hypertension

to ensure comparability of the GP and SHU populations. The three conditions for which I had data and which are related to hypertension were diabetes, hepatitis, and hyperlipidemia.

To ensure well-matched populations, all analyses excluded 78 prisoners with diagnosed mental illness; individuals with diagnosed mental illness are represented almost exclusively in the GP because they are not permitted to be housed in the SHU. In addition, analyses excluded 8 cases missing age information. This resulted in a final total sample of 939 prisoners, 425 in general population housing and 514 in the SHU.

**RESULTS**

1. **Hypertension prevalence in the total sample is greater in the SHU than the GP population.**[12]

In 939 prisoners, 18.4% of the GP population (78/425 prisoners) and 48.4% of the SHU population (249/514 prisoners) have hypertension (see Table 1; tables appear at the end of this report). In other words, the SHU population has a 4.2 times greater odds of having hypertension than the GP population. This is a statistically significant population difference in hypertension prevalence. Because the SHU population is older than the GP population and hypertension prevalence increases with age, I adjusted for age differences and found that the

[12] Estimates of hypertension rates in the non-imprisoned American population are not a relevant comparison for rates in the prison population. Such comparisons would not be appropriate because of differences in the environmental conditions to which the populations are exposed, health behaviors chosen versus imposed (e.g., exercise), when and how hypertension cases are ascertained, and differences in sampling (a random sample of the U.S. population versus a non-random sample of prisoners). To determine whether placing a prisoner in the SHU increases their risk of developing hypertension, the relevant comparison is between two highly similar populations, with similar environmental exposures, namely the restricted general prisoner population and the socially isolated SHU population.

difference in hypertension prevalence between the GP and the SHU remained statistically significant. The age-corrected odds were 3.9 times greater for the SHU than the GP population.

To examine whether population differences in hypertension prevalence differed across age, I categorized prisoners by age into approximately 10-year bins: 27-35, 36-45, 46-55, and 55-71 years old. Hypertension prevalence was higher in the SHU than the GP population for each of the four age groups (see Table 2). The youngest age group (27-35 years) had the largest difference; about 63% of the SHU population in this age group had hypertension as opposed to only 18% of the GP population. A statistical test revealed that this difference was significantly larger than the difference in the 46-55 year-old age group but no other age groups differed significantly in hypertension prevalence relative to the youngest age group.

**2. Hypertension prevalence in the sample imprisoned 10 or more years is greater in the SHU than the GP population.**

Among prisoners who have been imprisoned ten years or more, 11.2% of the GP population (32/285) and 25.7% of the SHU population (63/245) has hypertension (see Table 3). In those imprisoned 10 years or more, the odds of hypertension are 2.7 times greater in the SHU prisoners than the GP prisoners. The age-corrected odds are 1.5 times (i.e., 50%) greater in the SHU than the GP population, a sizeable effect that, although not statistically significant from a scientific perspective (in large part because of the small sample size), is large from a practical perspective[13]. A 50% greater odds of hypertension associated with social isolation exceeds the

[13] By way of comparison, the touted effects of aspirin for reducing the odds of subsequently suffering a heart attack or death are small by comparison; relative to placebo users, aspirin users experience only a 32% reduction in heart attack and a 15% reduction in mortality. He, J., Whelton, P. K., Vu, B., & Klag, M. J. (1998). Aspirin and risk

risk associated with overweight, for example, and is consistent with the research described above which found that the effect of social isolation on mortality risk exceeded that of traditional risk factors such as overweight.

As part of the data set provided to me, I had information on one other factor besides age which is relevant to risk for hypertension. Hypertension is not the only health condition with which prisoners are diagnosed, and differences in their overall health status will generally affect their risk for hypertension independently of social isolation. To address whether social isolation increases risk for hypertension independently of health status, statistical adjustment must be made to equate for health status in the SHU and GP populations. I conducted such an analysis by adjusting for three conditions that are known to increase risk for hypertension. Diabetes was present in 10 prisoners, hepatitis in 48 prisoners, and hyperlipidemia in 21 prisoners. After adjusting for each of these conditions and for age, the corrected odds of hypertension are 2.2 times greater in the SHU than the GP population, a difference that is statistically significant. These results suggest that the social isolation experienced by the SHU population increases risk for hypertension over and above the risk for hypertension posed by other health conditions from which these prisoners suffer.

The SHU population had consistently higher hypertension prevalence than the GP population across all age groups. Statistical tests revealed that differences in hypertension prevalence between the SHU and GP populations were comparable in each age group. However, as shown in Table 4, some of the age groups were poorly represented by GP

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of hemorrhagic stroke: A meta-analysis of randomized controlled trials. *Journal of the American Medical Association, 280*, 1930-1935.

prisoners (6 who were 55-71 years old) or SHU prisoners (5 who were 27-35 years old), or were small in size overall (only 34 prisoners are 55-71 year-olds), precluding definitive conclusions.

More reliance can be placed on the findings observed in the largest age group, 243 individuals aged 36-45 years. In this age group, 20% of SHU prisoners have hypertension as opposed to 11% in the GP. This effect is substantively important - most people who get hypertension develop the condition in their 50s and 60s. That a much larger percentage of the SHU population in the 36-45 year old age group has developed hypertension suggests that social isolation itself, and not simply the aging process, is causing the increased hypertension. In fact, hypertension prevalence in the youngest age group of SHU prisoners (i.e., 20%) approaches rates observed in the older 46-55 year-old group of general population prisoners (23% have hypertension), as though the influence of social isolation prematurely ages the cardiovascular system.

Given that hypertension causes damage to the blood vessels and heart, the younger the development of hypertension, the earlier the predicted onset of more serious cardiovascular conditions such as heart disease and stroke. The substantially higher percentage of 36-45 year olds in the SHU who have hypertension therefore would predict significantly earlier and higher rates of chronic and potentially fatal cardiovascular conditions later in life for the prisoners who are subjected to the severely isolating conditions of the SHU.

**CONCLUSIONS**

1) From my own work and others', people who are socially isolated have increased rates of hypertension, chronic cardiovascular diseases such as heart disease and stroke, and early mortality. My analyses are consistent with the overall research. The data clearly show that hypertension is more prevalent in the highly socially isolated long-term SHU prisoners (i.e., 10 years or more) than in long-term prisoners in the only slightly less restricted general prison population, even after adjusting for the age difference between the two populations. The difference in hypertension prevalence was even greater after also adjusting for general health status, and exceeded the magnitude of risk associated with overweight, physical inactivity, and smoking.
2) The analyses of the PBSP data are not only consistent with the overall research, but strengthen the hypothesized causal link between social isolation and hypertension. The gold standard for causality requires random assignment to one or another condition, where the only difference between the conditions is the presence or absence of the presumed causal factor (e.g., social isolation). In the non-prison population, it is impossible and unethical to conduct an experiment that randomly assigns individuals to social isolation for any length of time. The situation with the SHU and GP prisoners, on the other hand, constitutes a natural experiment of sorts. The SHU and GP populations have highly comparable daily experiences with the exception of the much greater absence of meaningful social contact in the SHU relative to the GP population. Assuming that prisoners assigned to the SHU have similar criminal and social backgrounds, the primary difference between the two populations is the

extent of their social isolation. This permits inferring that extreme social isolation causes the difference in hypertension rates in the two populations.

3) There could be other differences between the populations that are associated with hypertension risk and that were not able to be considered due to the absence of data, including racial-ethnic identity, and if, when, and how long current GP prisoners had spent time in the SHU in the past. However, adjusting for the foregoing differences may well exacerbate the hypertension risk for SHU relative to GP prisoners. Moreover, the SHU prisoner disadvantage in hypertension risk persisted in analyses that adjusted for age and health differences. The persistence of the effect of social isolation on hypertension after adjusting for the factors available to me indicates that social isolation is robustly related to hypertension.
4) Hypertension was more common in the SHU than the GP population across all ages, but the difference was most pronounced in <u>younger</u> prisoners. By older age, normal age-related physiological changes result in increased blood pressure for all adults, which could diminish or abolish the ability to detect any additional effects of social isolation. For the SHU population, relative to the GP population, age-related physiological changes are superimposed on a higher probability of hypertension at a younger age. The fact that younger SHU prisoners are being diagnosed with hypertension at higher rates than their age-matched GP counterparts has grave implications for their future health. The long-term consequences of hypertension indicate that SHU prisoners are set on a trajectory toward early onset cardiovascular disease and mortality. Hypertension treatment, to the extent blood pressure levels are successfully controlled, ameliorates the long-term consequences

to some extent, but by the time hypertension is diagnosed, damage to the cardiovascular system, some of it irreversible, has already begun. Thus, young SHU prisoners have more serious consequences beyond hypertension to anticipate in their future health, and their future will be upon them sooner than it would if they were not subjected to the extreme social isolation of long-term SHU housing.

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Louise C. Hawkley

Date: March 12, 2015

Table 1. Hypertension prevalence by prison type.

| | GP | SHU | Total # of prisoners |
|---|---|---|---|
| No hypertension | 347 (81.7%) | 265 (51.6%) | **612** |
| Hypertension | 78 (18.4%) | 249 (48.4%) | **327** |
| **Total # of prisoners** | **425** | **514** | **939** |

1.1. A logistic regression showed higher odds of hypertension in the SHU than the GP, OR=4.18 (SE=0.64), $p<.001$, 95% CI: 3.10, 5.64.

1.2. A logistic regression that adjusted for age showed higher odds of hypertension in the SHU than the GP, OR=3.88 (SE=0.65), $p<.001$, 95% CI: 2.80, 5.37. Age had a nonsignificantly positive association with hypertension, OR=1.01 (SE=0.01), $p=.259$, 95% CI: 0.99, 1.03.

Table 2. Hypertension prevalence, by prison type and age decade.

| **Age group**[14] | **GP** | **SHU** | **Total # of prisoners** |
|---|---|---|---|
| Age 27-35 | 36 (17.5%) | 35 (62.5%) | |
| # of prisoners | 206 | 56 | **262** |
| Age 36-45 | 24 (15.3%) | 108 (44.1%) | |
| # of prisoners | 157 | 245 | **402** |
| Age 46-55 | 14 (25.9%) | 70 (42.9%) | |
| # of prisoners | 54 | 163 | **217** |
| Age 55-71 | 4 (50.0%) | 36 (72.0%) | |
| # of prisoners | 8 | 50 | **58** |
| **Total # of prisoners** | **425** | **514** | **939** |

2.1 A logistic regression showed a significant interaction between age group and prison population type only for 46-55 year-olds relative to 27-35 year-olds, $p$=.007. Specifically, the population difference in hypertension rates was lower in 46-55 year-old prisoners than in their 27-35 year-old counterparts, but SHU and GP population differences in hypertension in the 36-45 year-olds and 55-71 year-olds did not differ significantly from rates in the 27-35 year-olds, $p$'s >.16.

[14] Age groups started at age 27 and ended at age 71 because the age range of prisoners in the data ranged from 27 to 71 years.

Table 3. Hypertension prevalence in prisoners imprisoned for 10 or more years, by prison type.

| | GP | SHU | Total # of prisoners |
|---|---|---|---|
| No hypertension | 253 (88.8%) | 182 (74.3%) | **435** |
| Hypertension | 32 (11.2%) | 63 (25.7%) | **95** |
| **Total # of prisoners** | **285** | **245** | **530** |

3.1. A logistic regression showed significantly higher odds of hypertension in the SHU than the GP, OR=2.74 (SE=0.65), $p<.001$, 95% CI: 1.72, 4.36.

3.2. A logistic regression that adjusted for age showed nonsignificantly higher odds of hypertension in the SHU than the GP, OR=1.52 (SE=0.40), $p=.116$[15], 95% CI: 0.90, 2.56. Age had a significant positive association with hypertension, OR=1.08 (SE=0.02), $p<.001$, 95% CI: 1.05, 1.12.

3.3. A logistic regression that adjusted for age and the presence of asthma, diabetes, hepatitis, and hyperlipidemia showed significantly higher odds of hypertension in the SHU than the GP, OR=2.22 (SE=0.69), $p=.01$, 95% CI: 1.21, 4.11. Age had a significant positive association with hypertension, OR=1.04 (SE=0.02), $p=.036$, 95% CI: 1.002, 1.08. Diabetes was perfectly correlated with hypertension; all of the individuals with diabetes also had hypertension. Hepatitis had a significant positive association with hypertension, OR=2.78 (SE=1.09), $p=.009$, 95% CI: 1.29, 6.01. Hyperlipidemia also had a significant and large positive association with hypertension, OR=16.02 (SE=12.9 6), $p=.001$, 95% CI: 3.28, 78.16.

[15] $p=.116$ signifies that the probability of another study finding a difference in hypertension prevalence in the SHU relative to the GP population is approximately 88%, or in other words, that the likelihood that the results obtained in this data analysis were random is less than 12 percent.

Table 4. Hypertension prevalence in prisoners imprisoned for 10 or more years, by prison type and age decade.

| **Age group**[16] | **GP** | **SHU** | **Total # of prisoners** |
|---|---|---|---|
| Age 27-35 | 6 (5.4%) | 1 (20.0%) | |
| # of prisoners | 111 | 5 | **116** |
| Age 36-45 | 14 (11.2%) | 24 (20.3%) | |
| # of prisoners | 125 | 118 | **243** |
| Age 46-55 | 10 (23.3%) | 23 (24.5%) | |
| # of prisoners | 43 | 94 | **137** |
| Age 55-71 | 2 (33.3%) | 15 (53.6%) | |
| # of prisoners | 6 | 28 | **34** |
| **Total # of prisoners** | **285** | **245** | **530** |

4.1. A logistic regression showed nonsignificant interactions between age decade and prison population type, *p*'s > .26. These results signify that with each older age decade, the odds of hypertension increased equivalently in the SHU and the GP. The difference between the SHU and GP lies in the greater odds of hypertension in younger SHU than GP prisoners; the physiological effects of aging are superimposed on a higher rate of hypertension at a younger age in the SHU population.

[16] Age groups started at age 27 and ended at age 71 because the age range of prisoners in the data ranged from 27 to 71 years.