ENCOURAGE. RECOGNIZE. CELEBRATE.

NSURJ

Nevada State Undergraduate Research Journal

Volume 8 Issue 1 2023

Nevada State Undergraduate Research Journal

2022-2023

Volume 8 Issue 1

Spring 2023

Published online at scholarworks.unr.edu by the

Associated Students of the University of Nevada (ASUN)

3rd Floor Joe Crowely Student Union Mailstop 058

University of Nevada, Reno

Reno, NV 89557

DOI: http://dx.doi.org/10.15629/6.7.8.7.5

ISSN: 2375-4826

Table of Contents

Volume 8 Issue 1 Spring 2023

LETTER FROM THE EDITORS

NSURJ is excited to present:

Volume 8 Issue 1 Spring 2023

The Nevada State Undergraduate Research Journal (NSURJ) was established in 2014 by the Associated Students of the University of Nevada (ASUN) to offer undergraduate students in the higher education system of Nevada the opportunity to demonstrate their intellectual merit by publishing their outstanding work in a unified, scholarly, peer-reviewed journal. NSURJ strives to provide an accessible, peer-reviewed journal specifically for undergraduate students in all NSHE institutions, showcasing the quality of a Nevada education and professionalizing students' education and experiences through the important milestone of publication. The journal creates scholarly connection between peers and mentors creating an allowance for professional development in public speaking, research, and academic branching.

Volume 8 marks 9 years since the publication first volume of the journal, signaling continuous growth and support from Nevadan Undergraduates. Volume 8 marks another opportunity for undergraduate researchers to develop pre-professional academic careers while giving a voice to their original research.

In 2021, NSURJ officially became a unit of Undergraduate Research under Research and Innovation. Growth and communication between researchers of all disciplines and those who value and want to publish their work was greater than it has been in the past. Researchers were offered workshop experiences to further their success in publication writing, while also gaining experience in what will be expected of them in less pre-professional formats.

Students demonstrated excellence in their academic merit, shining a bright light at the end of the pandemic that threatened life on Earth just three years ago. The continuation of this journal could not have been possible without the amazing work brought on by those students who prevailed in research beyond impossible odds. The editors of this edition could not be more grateful to those who supported the undergraduate researchers and those who supported the journal itself.

The fate of NSURJ is in the hands of the students, faculty, and those who make undergraduate research possible. This is a journal led by the students for the students, and as the senior editors lay the journal in the hands of our predecessors we must remind our supporters the importance of that which is the growth of undergraduate research and the connections made between editors and researchers.

Sincerely,

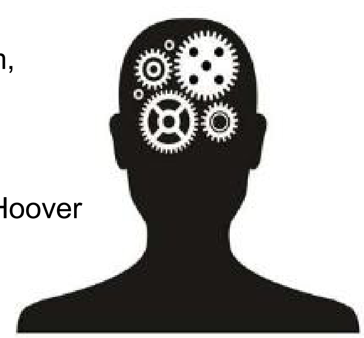
Co-Senior Editors

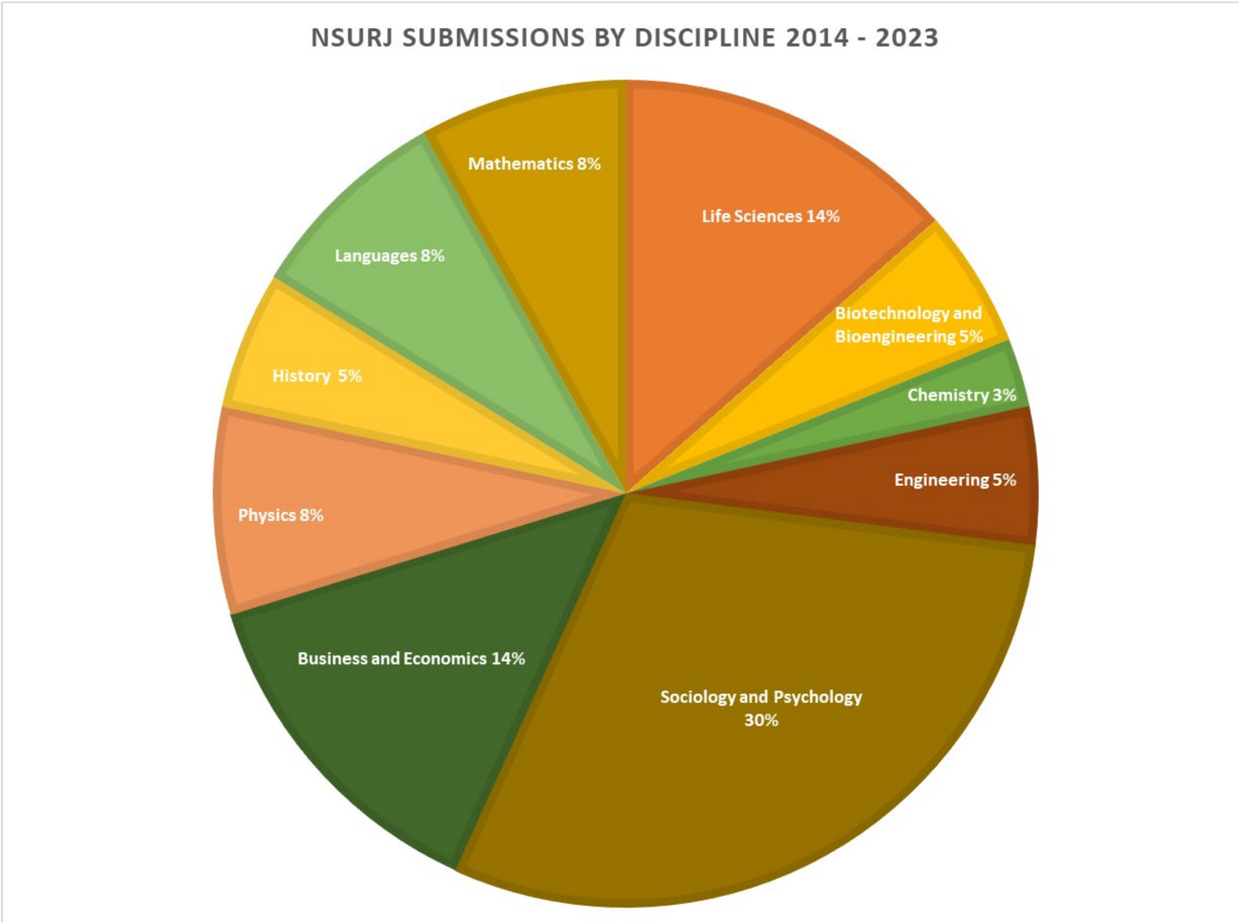
Pantera Kivisto, Lucy Burnham,

& Jeremy Guevin

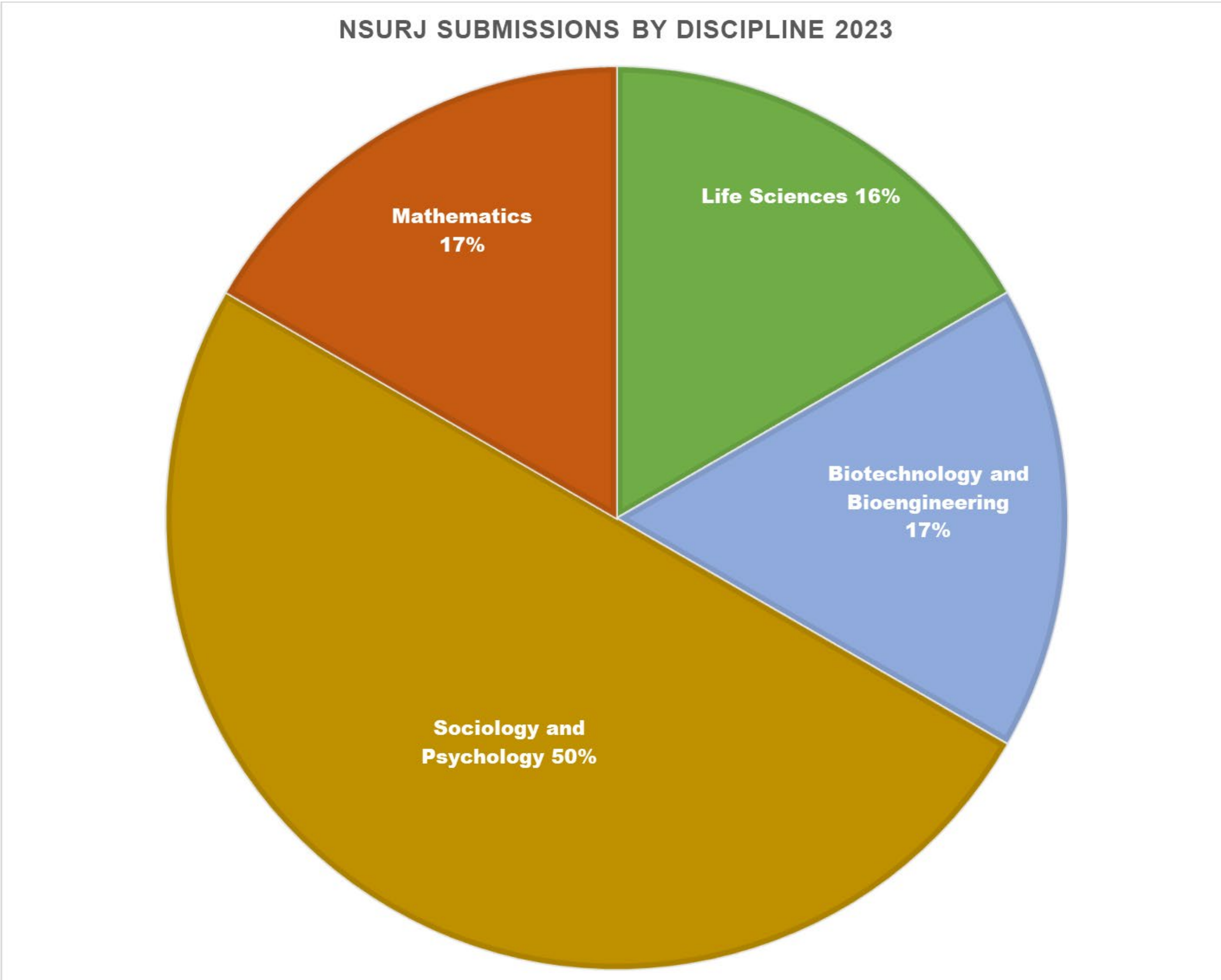
Co-Junior Editors

Jaiden Christopher & Anders Hoover





Statistics 1. NSURJ Submissions by Discipline 2014-2023. NSURJ initially published its first edition in 2014 featuring a wide range of interdisciplinary authors. Since then, editors have been keeping track of each discipline featured in every edition. NSURJ continues to fulfill its role as an interdisciplinary publication.



Statistics 2. NSURJ Submissions by Discipline 2023. NSURJ continues to fulfill its role as an interdisciplinary publication. Edition 8 successfully features at least four disciplines under umbrella identifications.

Application of Machine Learning in Clear Cell Renal Cell Carcinoma Prediction

Kurtis Bertauche[1,2] and So Young Ryu[1]
[1]Department of Epidemiology, Biostatistics, Environmental Health Sciences, School of Public Health, University of Nevada Reno, Reno, Nevada
[2]Department of Computer Science and Engineering, University of Nevada Reno, Reno, Nevada

Abstract

Clear cell renal cell carcinoma (ccRCC), the most prevalent kidney cancer, is one of the leading causes of cancer-related deaths. Proteomics, which is the study of proteins, can provide biological insights about the development of ccRCC tumors that genomics alone cannot provide. Such insights may enhance our ability to effectively treat ccRCC patients. Here, the potential of proteomics in ccRCC was further explored. Specifically, machine learning models (e.g., Extreme Gradient Boosting, Random Forest, and two Support Vector machines) were built that classify tissue samples as ccRCC tumor tissue or normal tissue using proteomics data. The proposed machine learning models performed very well in differentiating between ccRCC tumor tissue vs. normal tissue with their accuracies of nearly 98%. Despite the limitations of our study (e.g., small sample size, correlation), we believe that the study demonstrated the potential of proteomics in ccRCC tumor predictions.

Introduction

Renal cell carcinomas (RCCs) encompass a diverse set of cancers, not all entirely related to one another, with differing genetic causes and widely varying treatment methods and outcomes. (Linehan et al., 2003; Jonasch et al., 2014) Some of the most common cancers classified as renal cell carcinomas include Papillary RCC, Chromophobe RCC, and Clear Cell RCC (ccRCC). (Jonasch et al., 2014) Of these diseases, ccRCC is the most prevalent, constituting 70% of cases of all kidney cancers, not exclusive to carcinomas. (American Cancer Society, 2013) Not only is ccRCC the most prevalent of all kidney cancers, but it is also one of the leading causes of cancer-related deaths. (Hsieh et al., 2017)

Common treatments for ccRCC include cytotoxic chemotherapies. However, these chemotherapies often face disease resistance, of which the underlying causes are still largely not understood, leading to poorer outcomes in many cases. (Diamond et al., 2015) In order to better understand the role of genetics in both the causes and relative successes of treatments of ccRCC, previous studies have sought to investigate the genetic causes through extensive genomic sequencing of ccRCC tumors and analyses. (Hsieh et al., 2018) Despite thorough efforts, a full understanding of genetic mechanisms leading to ccRCC is still not fully grasped. (Nargund et al., 2017) With the gap of understanding from a purely genomic point of view in ccRCC, other studies have proposed to include proteomic data to help bridge the gap. By combining proteomic, phosphoproteomic, genomic, epigenomic, and transcriptomic analyses, new understandings and observations into ccRCC have been made, furthering the understanding of the functioning of the disease and helping to provide a path for discovering more effective treatments. (Clark et al., 2019)

To further illustrate the unique and important role of proteomic data in the study of ccRCC, in this study we seek to identify tissue samples as ccRCC tumors or normal tissue through purely proteomic means. By demonstrating the ability of only proteomic data to identify the presence of ccRCC tumors, we further validate the importance of the inclusion of proteomics data in the study of ccRCC.

Methods

Data

The dataset contains a total of 194 tissue samples from ccRCC patients. (Clark et al., 2019) Of those 194 samples, 110 were from ccRCC tumors and 84 were from normal tissues adjacent to the tumors. The collected ccRCC tumors had not been exposed to any treatment at the point when the samples were collected. From these samples, the relative abundances of 4,483 proteins were obtained. All these protein abundances were used as predictor variables in all of the models.

Models

Three different baseline models were constructed to predict whether the sample was sourced from a ccRCC tumor or from normal tissue. All three models were penalized linear regression models, specifically, Lasso, Ridge, and Elastic Net Regression.
Four new machine learning models were proposed to predict the presence of a tumor sample:

- Extreme Gradient Boosting
- Random Forest
- Support Vector Machine (Linear Kernal)
- Support Vector Machine (Radial Kernel)

Previous studies predicting other information relating to ccRCC, specifically the risk of death and the Fuhrman grade of ccRCC, using imaging, have found success using these types of models, suggesting potential applicability to their usage in other ccRCC prediction tasks. (Nazari et al., 2021; Lin et al., 2019)

Training

The data set was split into a training set (80%) and a testing set (20%). All decisions affecting the performance of the model were made with the training set, and the only usage of the testing set was purely for the evaluation of the completed models.

Lasso and Ridge Regression

Lasso and Ridge Regression are both forms of penalized regression, where the coefficients of a linear model are scaled to improve model performance. In Ridge Regression, none of the coefficients can ever be completely scaled to zero eliminating them from the model, as opposed to Lasso Regression where coefficients can be removed from the model by scaling them all the way to zero.
To train both Lasso and Ridge Regression models, the training set was used in a five-fold cross validation to tune the value of the parameter, responsible for controlling the amount of scaling to the coefficients in the model. After finding the optimal value of this parameter through tuning, the final model was constructed using the entire training set and subsequently evaluated using the testing set.

Elastic Net Regression

Elastic Net Regression combines the penalization properties of both Lasso and Ridge Regression and introduces an additional parameter that controls the mix between the two types of regression. To train the Elastic Net Regression model the training set was used in a five-fold cross validation to tune the parameters. After finding the optimal parameter values, the entire training set was used to create the final Elastic Net Regression model which was then evaluated with the testing set.

Random Forest

The Random Forest model was built by tuning both the number of variables to select from in each round and the number of trees in the model. To tune the model, the entire training set was used, and the Out of Bag (OOB) error was used to evaluate each potential model. After finding the optimal set of parameters within the search space for the parameters, the entire training set was used to build the final model and then the model was evaluated using the testing set.

Support Vector Regression

A Support Vector model seeks to find a hyperplane in a p-dimensional space which can best divide the data into outcome categories where p is the number of predictor variables. Support Vector models were trained with either a linear kernel (also known as a Support Vector classifier) or a radial basis kernel. For a Support Vector model with a radial basis kernel, the parameter that determines non-linearity was set to be 1 divided by p by default where p is the number of parameters. For both models, five-fold cross validation was used to tune the cost parameter based upon model accuracy. After finding the optimal value for the cost parameter, the entire training set was used to build the final model and then evaluated on the testing set.

Extreme Gradient Boosting

Extreme Gradient Boosting models have a large number of parameters that can be tuned. The following six parameters in the xgboost package were tuned:

- Gamma
- Child_weight
- Max_depth
- Subsample
- Col_subsample
- ETA

The training set and five-fold cross validation were used to tune these parameters. After completion of tuning, the entire training set was used to build the final model which was then evaluated with the testing set.

Software and Reproducibility

All of the discussed models were produced in R (R Core Team, 2021) using the following packages:

- glmnet (Friedman et al., 2010)
- caret (Kuhn, 2021)
- ROCR (Sing et al., 2005)
- e1071 (Meyer et al., 2021)
- xgboost (Chen et al., 2021)
- ranger (Wright & Ziegler, 2017)

Additionally, in any process that involved randomness, the seed value was fixed at 37 to ensure the ability to reproduce results found in this study. The code can be found at https://github.com/soyoungryu/TumorPrediction.

Model Evaluation

In order to be able to fairly and accurately evaluate all of the models, all decisions regarding the construction and choice of parameters for all models were based solely upon observations of the training set. Consequently, all model evaluation was then performed using the same testing set. Given that the models were predicting a binary outcome, evaluation metrics for classification were used. First, a confusion matrix was defined for the data. A confusion matrix allows for classification of different types of errors possible in a model with a binary outcome, such as incorrectly identifying a tumor sample as normal tissue as compared to incorrectly identifying normal tissue as a tumor sample. In the confusion matrix, a tumor sample was defined as a “positive” outcome and a normal tissue sample as a “negative” outcome, resulting in the following construction of a confusion matrix:

Table 1
Definition of Confusion Matrix

	Actual Positive	Actual Negative
Positive Prediction	True Positive (TP)	False Positive (FP)
Negative Prediction	False Negative (FN)	True Negative (TN)

With the confusion matrix defined, definitions for model evaluation based upon the definitions provided in the confusion matrix could be defined. Accuracy (ACC) was defined as the total number of true positives and true negatives divided by the total number of observations, as follows:

$$ACC = \frac{TP + TN}{TP + TN + FP + FN}$$

Sensitivity, also called True Positive Rate (TPR) was defined by the total number of true positive predictions divided by the sum of true positive predictions and false negative predictions. Conversely, specificity, also called True Negative Rate (TNR) was defined by the total number of true negative predictions divided by the sum of true negative predictions and false positive predictions. Both are given as follows:

$$TPR = \frac{TP}{TP+FN} \qquad TNR = \frac{TN}{TN+FP}$$

Additionally, the positive predictive value (PPV) and the negative predictive value (NPV) were calculated for all the models. Positive predictive value was defined by the number of true positive predictions divided by the sum of true positive predictions and false positive predictions. Negative predictive value was defined as the number of true negative predictions divided by the sum of true negative predictions and false negative predictions. The definitions for positive predictive value and negative predictive value are shown below, respectively:

$$PPV = \frac{TP}{TP+FP} \qquad NPV = \frac{TN}{TN+FN}$$

The false positive rate (FPR) as well as the false negative rate (FNR) were also calculated. False positive rate was defined by the number of false positive predictions divided by the sum of false positive predictions and true negative predictions. False negative rate was defined by the number of false negative predictions divided by the sum of false negative predictions and true positive predictions. Both were defined as shown below, respectively:

$$FPR = \frac{FP}{FP+TN} \qquad FNR = \frac{FN}{FN+TP}$$

The F_β scores for the models were also calculated. This score was used to measure the accuracy of the model, where the value of β can be altered to stress the importance of positive predictive value over true positive rate and vice versa. The F_β score was calculated as follows:

$$F_\beta = (1+\beta^2) \cdot \frac{TPR \cdot PPV}{(\beta^2 \cdot PPV) + TPR}$$

The values of 1 and 2 as β were used in calculating the F_β scores for the models. Using the value of 1 calculates the harmonic mean of PPV and TPR, while the increase in β to 2 allowed for calculating the performance with a stronger emphasis on the importance of the true positive rate of the models.

Youden's J statistic was also calculated for all the models. False positive and false negative predictions are weighted equally in Youden's J statistic making it a good method for briefly understanding overall model performance. Youden's J statistic was defined as follows:

$$Youden's\ J\ Statistic = TPR + TNR - 1$$

Finally, the area under the receiver operating characteristic (ROC) curve was calculated. The area under the curve (AUC) allowed for understanding how well the model is able to separate the data into respective classes (positive and negative). A value of 1 represented a model that made no errors, the model was able to perfectly separate data into the correct divisions. A value of 0.5 means that the model had no ability to predict data as one class or another, predictions were essentially equivalent to a random decision. A value of 0 means that the model was able to distinguish data into separate classes, but it did it backwards. In other words, the model predicted positive values as negative values and negative values as positive values. The AUC values were calculated using the ROCR package in R.

Results and Discussion

A table summarizing the evaluation metrics provided in the previous section for all the baseline models is shown below in table 2.

Table 2

Evaluation of Baseline Models

Evaluation Metric	Lasso Regression	Ridge Regression	Elastic Net Regression
Accuracy	0.947	0.947	0.974
Sensitivity	1	1	1
Specificity	0.889	0.889	0.944
False Positive Rate	0.111	0.111	0.056
False Negative Rate	0	0	0
Positive Predictive Value	0.909	0.909	0.952
Negative Predictive Value	1	1	1
Area Under Curve	0.967	0.986	0.987
$\boldsymbol{F_1}$ Score	0.952	0.952	0.976
$\boldsymbol{F_2}$ Score	0.980	0.980	0.990
Youden's J Statistic	0.889	0.889	0.944

All of the baseline models showed similar performance, with identical sensitivities as well as identical false negative rates. This means that none of the baseline models falsely identified a tumor sample as a normal tissue sample. While the Lasso and Ridge Regression models shared very similar performance metrics, the elastic net model produced slightly better results, with an increased accuracy of 0.974, increased specificity of 0.955, as well as an increased area under the ROC curve, F_1 score, F_2 score, and Youden's J statistic. This is due to the Elastic Net Regression model identifying a lesser number of normal tissue samples as tumor samples, resulting in less false positives.

A table summarizing the evaluation metrics for all the proposed models is shown in table 3.

Table 3
Evaluation of Proposed Models

Evaluation Metric	Linear Support Vector Machine	Radial Support Vector Machine	Random Forest	Extreme Gradient Boosting
Accuracy	0.974	0.921	0.974	0.974
Sensitivity	1	1	1	1
Specificity	0.944	0.833	0.944	0.944
False Positive Rate	0.056	0.167	0.056	0.056
False Negative Rate	0	0	0	0
Positive Predictive Value	0.952	0.870	0.952	0.952
Negative Predictive Value	1	1	1	1
Area Under Curve	0.989	0.969	0.986	0.989
$\boldsymbol{F_1}$Score	0.976	0.930	0.976	0.976
$\boldsymbol{F_2}$Score	0.990	0.971	0.990	0.990
Youden's J Statistic	0.944	0.833	0.944	0.944

The proposed models showed similar results to the Elastic Net Regression model from the baseline models, with the exception of the radial Support Vector machine. The Support Vector machine with a radial basis kernel performed worse than all other models across every performance metric with the exception of area under the ROC curve, incorrectly identifying more samples than any other model. This may be due to using a default nonlinearity parameter. Tuning of this parameter may improve the performance of the Support Vector machine with a radial basis kernel. Overall, the Elastic Net Regression, linear Support Vector machine, Random Forest, and Extreme Gradient Boosting models produced the highest performances in terms of their accuracy and sensitivity/specificity. All four models shared identical measures for:

- Accuracy (0.974)
- Sensitivity (1)
- Specificity (0.944)
- False positive rate (0.056)
- False negative rate (0)
- Positive predictive value (0.952)
- Negative predictive value (1)
- F_1 score (0.976)
- F_2 score (0.990)
- Youden's J statistic (0.944).

This means that all these models identified the same number of true positive, true negative, false positive, and false negative samples. Among these four models, the linear Support Vector machine and the Extreme Gradient Boosting model had a slightly better AUC value of 0.989, making the linear Support Vector machine and the Extreme Gradient Boosting models the highest performing models in this study. While many of the models shared identical performance metrics, the variance in AUC is explained in how AUC is calculated. All the other performance metrics besides AUC only use the counts of the true positives, true negatives, false positives, and false negatives for calculations. However, AUC also uses the probabilities of each identification. The probabilities of each identification can be viewed as the confidence in each identification by the model. Thus, AUC delivers higher performance metrics for a model that correctly identifies a sample with a higher confidence as opposed to a model with correctly identifies a sample with a lower confidence.

None of the models predicted any false negatives, which leads to all the models sharing the same sensitivity (1), false negative rate (0), and negative predictive value (1). This means that none of the models falsely identified a tumor sample as being a normal tissue sample. While a lack of false negatives showed impressive model performance, it is also possible that a larger sample size would have produced false negatives. Limitations to this study result from the usage of a single data set with a limited number of observations.

Besides the sample size limitation, another limitation of the study is that the proposed models did not consider correlations between tumor and normal tissues from the same individuals. Thus, the performances of the models may be more optimistic than reality. Noting that the pair-matched information between tumor and normal tissues is known in this dataset, developing prediction models that incorporates the correlations between observations will be necessary in the future.

Conclusion

In this study, high model performance was defined by performance metrics as close to the value 1 as possible, except for false positive rate and false negative rate, where high performance was defined by a value as close to 0 as possible. By maximizing and minimizing these quantities we attempted to find models that correctly identified the greatest number of samples. The AUC value was used in the case of identical performance measures to reward models with higher confidences in correct identifications with a higher performance measure.

All the models have shown excellent performances with the Extreme Gradient Boosting and Linear Support Vector Machine models showing the highest performances, indicating that these models both correctly identified the greatest number of samples and did so with the highest confidences compared to the other models. The results showed that proteomics data is indeed a very important factor in the study of ccRCC, as nearly 98% of samples were correctly identified using only proteomics data in the best models. Furthermore, this was done without any false negative identifications and with high AUC metrics, showing that most identifications were made with relatively high confidence, further verifying proteomics as an effective tool in ccRCC identification. The further development of ccRCC tumor prediction model may lead to an alternative proteomic based approach to identify ccRCC tumors in the future.

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant No. 2046122 for KB and SR and the National Institute of General Medical Sciences/National Institutes of Health under Grants GM103440 and 1R15GM126562–01 for SR. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the funding agencies. The authors thank other Ryu Computational Group members (Gabriella Goodwin and Carle Henke) for helpful discussion and support.

References

American Cancer Society. (2013). *Cancer facts and statistics*. American Cancer Society. Retrieved October 12, 2022, from https://www.cancer.org/research/cancer-facts-statistics.html

Chen, T., He, T., Benesty, M., Khotilovich, V., Tang, Y., Cho, H., Chen, K., Mitchell, R., Cano, I., Zhou, T., Li, M., Xie, J., Lin, M., Geng, Y., & Li., Y. (2021). xgboost: Extreme

Gradient Boosting. R package version 1.4.1.1. https://CRAN.R-project.org/package=xgboost

Clark, D. J., Dhanasekaran, S. M., Petralia, F., Pan, J., Song, X., Hu, Y., Leprevost, F. V., Reva, B., Lih, T. M., Chang, H., Ma, W., Huang, C., Ricketts, C. J., Chen, L., Krek, A., Li, Y., Rykunov, D., Li, Q. K., Chen, L. S., … Zhang, H. (2019). Integrated Protogenomic Characterization of Clear Cell Renal Cell Carcinoma. *Cell 179*(4), 964-983. https://doi.org/10.1016/j.cell.2019.10.007

Diamond, E., Molina, A. M., Carbonaro, M., Akhtar, N. H., Giannakakou, P., Tagawa, S. T., & Nanus, D. M. (2015). Cytotoxic chemotherapy in the treatment of advanced renal cell carcinoma in the era of targeted therapy. *Critical Reviews in Oncology/Hematology*, *96*(3), 518–526. https://doi.org/10.1016/j.critrevonc.2015.08.007

Friedman, J., Hastie, T., & Tibshirani, R. (2010). Regularization Paths for Generalized Linear Models via Coordinate Descent. *Journal of Statistical Software*, *33*(1), 1-22. https://www.jstatsoft.org/v33/i01/.

Hsieh, J. J., Purdue, M. P., Signoretti, S., Swanton, C., Albiges, L., Schmidinger, M., Heng, D. Y., Larkin, J., & Ficarra, V. (2017) Renal cell carcinoma. *Nature Reviews Disease Primers 3* 17009. https://doi.org/10.1038/nrdp.2017.9

Hsieh, J. J., Le, V. H., Oyama, T., Ricketts, C. J., Ho, T. H., & Cheng, E. H. (2018). Chromosome 3p Loss-Orchestrated VHL, HIF, and Epigenetic Deregulation in Clear Cell Renal Cell Carcinoma. *Journal of Clinical Oncology, 36*(36), 3533-3539. https://doi.org/10.1200%2FJCO.2018.79.2549

Jonasch E., Gao J., & Rathmell W.K. (2014). Renal cell carcinoma. *BMJ*, *349* https://doi.org/10.1136/bmj.g4797

Lin, F., Cui, E., Lei, Y., & Luo, L., CT-based machine learning model to predict the Fuhrman nuclear grade of clear cell renal cell carcinoma. *Abdominal Radiology*, *44*, 2528–2534. (2019). https://doi.org/10.1007/s00261-019-01992-7

Linehan, W. M., Walther, M. M., & Zbar, B. (2003). The Genetic Basis of Cancer of the Kidney. *Journal of Urology*, *170*(6), 2163–2172. https://doi.org/10.1097/01.ju.0000096060.92397.ed

Max Kuhn, M., (2021). caret: Classification and Regression Training. R package version 6.0-88. https://CRAN.R-project.org/package=caret

Meyer, D., Dimitriadou, E., Hornik, K., Weingessel, A., & Leisch, F., (2021). e1071: Misc Functions of the Department of Statistics, Probability Theory Group. R package version 1.7-9. https://CRAN.R project.org/package=e1071

Nargund, A. M., Osmanbeyoglu, H. U., Cheng, E. H., & Hsieh, J. J. (2017). SWI/SNF tumor suppressor gene PBRM1/BAF180 in human clear cell kidney cancer. *Molecular & Cellular Oncology, 4(*4), https://doi.org/10.1080/23723556.2017.1342747

Nazari, M., Shiri, I., & Zaidi, H. (2021). Radiomics-based machine learning model to predict risk of death within 5-years in clear cell renal cell carcinoma patients. *Computers in Biology and Medicine*, *129*, 104135. https://doi.org/10.1016/j.compbiomed.2020.104135

R Core Team. (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Sing T., Sande,r O., Beerenwinkel, N., & Lengauer, T., (2005). ROCR: visualizing classifier performance in R. Bioinformatics, 21(20), 3940-3941. https://doi.org/10.1093/bioinformatics/bti623

Wright, M. N., & Ziegler, A. (2017). ranger: A Fast Implementation of Random Forests for High Dimensional Data in C++ and R. Journal of Statistical Software, 77(1), 1-17. https://doi.org/10.18637/jss.v077.i01

PREDICTED MAJOR ANNUAL PATHOLOGICAL CONSEQUENCES OF OBESITY – ENCOMPASSING CARDIOVASCULAR DISEASE WITH RESPECTIVE MORTALITY, CANCER WITH RESPECTIVE MORTALITY, TYPE II DIABETES MELLITUS, AND DEPRESSION WITH RELATED SUICIDE – ON UNITED STATES ADULT PUBLIC HEALTH FOR 2021-2022 BASED ON TRENDS FROM 2014-2020

Riley Gillis[1]
[1]Procter R. Hug High School; School of Public Health, University of Nevada Reno, Reno, Nevada

Abstract

This study reviewed data from 2014-2020 to predict quantifiable consequences of obesity in the forms of cardiovascular disease, cancer, type II diabetes, and depression for 2021-2022 United States adult public health using a trend analysis (linear regression and risk factor/proportional computations) methodology. The study estimates that obesity (83,910,380 and 85,887,840 cases estimated for 2021 and 2022 respectively) will account for 1,644,640 cases of heart disease with 62,810 respective deaths; 361,234 cases of cancer with 129,256 respective deaths; 10,396,300 cases of type II diabetes; and 3,092,100 cases of depression with 7,023 related suicides in 2021 and 1,683,400 cases of heart disease with 64,774 respective deaths; 367,090 cases of cancer with 131,352 respective deaths; 10,558,400 cases of type II diabetes; and 3,164,960 cases of depression with 7,219 related suicides in 2022. The implications of these data put obesity as one of the greatest threats to the American people, although several limitations to the data's absolute accuracy should be considered: confidence intervals are estimations, there may be confounding and extraneous variables, the study did not account for all comorbidities, the most current observed data is several years old, and predictions are never exact.

Predicted Major Annual Pathological Consequences of Obesity on United States Adult Public Health for 2021-2022 Based on Trends from 2014-2020

The United States of America is, without a doubt, one of the unhealthiest countries in the world when it comes to lifestyle. Despite being a 1st-world-country, not subject to many of the deficiencies that developing countries experience – like widespread famine, drought, profound poverty, or lack of medical care – America remains an incredibly unhealthy country. The recent COVID-19 pandemic has only exacerbated the already prevalent issue of an unhealthy base population in America and poses the question: why are people living in a 1st-world-country so prone to hospitalization and death when confronted with, in some cases, mild disease? When looking at disease/incident-related deaths, there is oftentimes the factual assertion that if a patient were healthier – if they didn't smoke, if they didn't have heart disease, if they weren't overweight or obese – they likely wouldn't have experienced serious illness or death as a result of that disease/incident. If we look at the case of a geriatric woman afflicted with common forms of an old-age-related brittle-bone disease who then falls and breaks her hip, was it the fall that caused the break? Certainly, if she simply had not fallen, she wouldn't have broken her hip – but the fall is not the only factor that contributed to the break; if this woman was younger and had healthier bones, then she likely would have gotten back up uninjured and continued with her day. If this is the case with a lot of serious injuries or illnesses, then why do we continue to look at lethal diseases such as COVID-19 like they are the only problem?

While it is important to look at the deaths being caused by something like COVID-19, it remains equally, or perhaps even more important, to inspect the elements that actually contribute to a patient's illness and deterioration rather than their speedy recovery. America has a long history of prominent underlying risk factors, ranging from smoking tobacco to old age, but this research was aimed at just one of them: obesity.

Literature Review

According to a number of the world's leading health organizations – the World Health Organization (2022); the (United States) Centers for Disease Control and Prevention (2021); and the National Heart, Lung, and Blood Institute (2022) – obesity is a condition defined by an abnormal accumulation of excessive adipose tissue resulting in a Body Mass Index (BMI) equal to or over 30 in an individual. BMI works by dividing the quantity of an individual's weight (lb) multiplied by 703, by their height (in.) squared (Shmerling, 2020). While BMI is not necessarily always accurately indicative of obesity as it may fail to classify metabolic health as it relates to weight distributions between muscle and fat in the body, it continues to be the standard determinant in the diagnosis of overweight and obesity in the medical community (Shmerling, 2020; Somers et al., 2005; CDC 2022, *Considerations for Practitioners*).

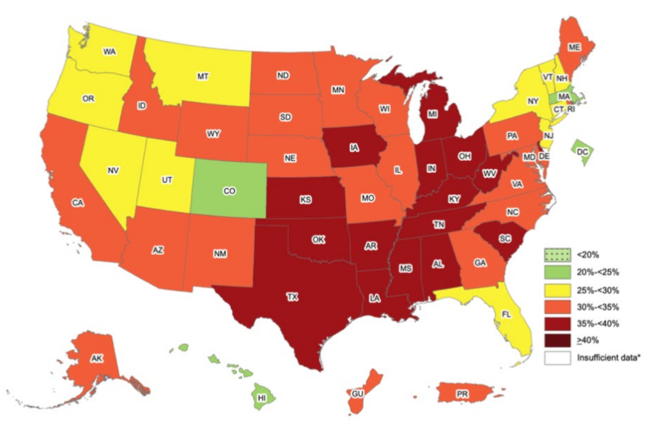
Social epidemiologists have determined that changes in social norms and the public's perception of obesity have resulted in higher obesity rates (Shoham et al., 2015; O'Callaghan, 2009). Despite cultural normalization of obesity as "non-threatening," however, studies still show that there is a diverse myriad of linked comorbidities – the coexistence of 2 or more conditions within an individual via direct causation, associated risk factors, heterogeneity, or independence (Valderas et al., 2009); in this case, direct causation and associated risk factors – illustrating the truly dangerous nature of the condition. Cardiovascular disease – known colloquially as heart disease – is consistently the world's number one killer, killing 18.56 million people globally in 2019 when compared to cancer in second (10.08 million) and respiratory diseases in third (killing 3.97 million) (Ritchie & Roser, 2018). Obesity is a major risk factor and a direct contributor to the development of the world's number one killer and its associated mortality (Powell-Wiley et al., 2021; Zhu et al., 2014; Quiñones-Ossa et al., 2021). For the purposes of this study, cardiovascular disease is defined as acute rheumatic fever, chronic rheumatic heart diseases, hypertensive heart disease, hypertensive heart and renal disease, ischaemic heart diseases (coronary artery disease), pulmonary heart disease and diseases of pulmonary circulation, and other forms of heart disease. Obesity has also been proven to be linked to higher occurrences of 13 types of cancer (these types of cancer make up 40% of all diagnosed cases, annually) (CDC, 2021, *Obesity and Cancer*), and has been heavily linked to diabetes mellitus type II, which is responsible for 85% of all leg amputations in the United States annually (73,000+) (Barnes, 2011; Caffrey, 2020). Furthermore, over the past several decades, it has even been determined that obesity is a serious risk factor for depression and subsequent suicide (Blasco et al., 2020). Given the synthesis of past data, it becomes incredibly evident that obesity is not something that should be normalized or accepted, instead, it is a debilitating affliction that contributes to the deaths of millions per year and should be addressed by the public as such. An important consideration for the treatment of this condition, however, does reside in the social stigma surrounding overweight and obesity, and mental health should be just as great of a concern as a risk factor as physical health (Puhl & Heuer, 2010) – i.e., making someone feel bad about their condition is never an effective treatment.

Obesity is incredibly prevalent in America (CDC, 2022, *Obesity, Race/Ethnicity, and COVID-19*) with 42.7% of our population suffering from the condition (see Figure 1), and given these linked comorbidities, is a true public health crisis for the United States.

Figure 1

Prevalence† of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2020

†Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.



Note: From Adult obesity facts. Centers for Disease Control and Prevention. https://www.cdc.gov/obesity/data/adult.html. Published September 30, 2021

While obesity does stem from a complex, multifactorial pathogenesis (lifestyle, mental health, genetics, environment, socio-economic class, etc.) (NICHD, 2022) and there is much debate over which primary risk factors the medical community should focus on (Blaun, 2012), one fact remains irrefutable: obesity is dangerously on the rise (CDC, 2021, *Adult Obesity Facts*) with more cases expected each year. With the recent public health crisis (COVID-19), more research needs to be done into obesity epidemiology and how much this condition is affecting our country, especially when obesity triples the risk of serious illness or death from conditions like COVID-19 (CDC, 2022, *Obesity, Race/Ethnicity, and COVID-19*). Not to mention, intuitively, sedentary lifestyle choices likely increased in the midst of the COVID-19-related public health restrictions, in turn contributing to a higher prevalence of obesity. There has been much analysis of the past, but little has been done to provide a synthesis of the predicted numbers of major obesity comorbidities in the United States for the future. This research aimed at finding what the predicted major annual pathological consequences of obesity – encompassing cardiovascular disease with respective mortality, cancer with respective mortality, type II diabetes mellitus, and depression with related suicide – are on United States adult public health for 2021-2022 based on trends from 2014-2020.

Through a trend analysis methodology via proportional computations and linear regression statistical analyses (Schneider et al., 2010), the numbers of linked comorbidity diagnoses and respective mortality can be predicted for United States adults for 2021-2022. Linear regression analysis attempts to model the relationship between two variables by fitting a linear equation to observed data (Yale, 2022) and then using the constructed line to predict values for one variable based on the values of the other at a specified point. Linear regression is often used in medicine to formulate predictions of data at a future date (Schober & Vetter, 2021) and, in the case of this research, was used to estimate future United States adult population numbers, obesity prevalence, and comorbid condition prevalence. Mathematical calculations with proportions were then made to attribute cumulative numbers of comorbid conditions to obesity using their respective increased risk factors (Willadsen et al., 2016; NCI, 2022). For example, if obesity increases the risk of developing a said condition by 10% and 20% of people will already naturally develop this said condition, then, on average, 2 per 100 (.01 x .2 = .02) obese people will develop this said condition as a result of their obesity. Lastly, if this said condition attributable to obesity is developed and only has an 85% survival rate in the first year, then, on average, .3 per 100 ((1-.85) x .02) obese people (or 1 per 334 obese people) will die because of that condition attributable to obesity within a year of the diagnosis. Using linear regression to predict the number of adults in the United States, their prevalence of obesity, and the prevalence of comorbid conditions attributable to obesity (after performing risk factor and proportion calculations on these data for each condition respectively) should yield an approximation of the numbers of major comorbidities attributable to obesity that we will observe in United States adults for the designated years (2021 and 2022).

Methodology

Trend analysis requires statistical calculations and interpretations of already obtained data to draw inferences, predictions, and conclusions. The first step that I took was to record data regarding the current public health climate of obesity, cardiovascular disease, cancer, type II diabetes mellitus, and depression respectively. The data for obesity prevalence and the prevalence of each respective comorbidity for each year (2014-2020) were obtained through the National Institutes of Health and the National Center for Health Statistics. The primary data reporting tool utilized in this research study for mortality was the CDCWONDER Underlying Cause of Death 1999-2020 database through the Centers for Disease Control and Prevention and the National Center for Health Statistics. All data disseminated through this tool can be used and published freely by anyone (CDC Wonder, 2022, *Frequently Asked Questions*) and exists for use by biostatisticians, epidemiologists, medical doctors, and other health professionals. The system uses a categorical data sorting method based on ICD-10 codes (International Classification of Diseases 10th Revision) to list and sort every recorded cause of death for specific regions in the United States with the added ability to designate which years (1999-2020); levels of urbanization (large central metro, large fringe metro, medium metro, etc.); age at death; day of the week person died on; if there was an autopsy; where they died (in-patient, out-patient, descendants home, etc.); genders; hispanic origin; and races/ethnicities that you would like to analyze. The results of all calculations are recorded in the **Results** section of this study.

United States Population (18+)

Using the CDCWONDER Bridged-Race Population Estimates 1990-2020 tool, the population data for those aged 18+ in 2014-2020 were obtained (see Table 1). Linear regression analysis was then conducted using a TI-nspire CX CAS to approximate predictions on future population numbers for adults in the United States. This same method will be utilized throughout this study for linear regression analysis.

Table 1

US Adult Population Estimates (2014-2020)

Yearly July 1st Estimates	Population
2014	244,793,112
2015	247,085,274
2016	249,372,462
2017	251,489,792
2018	253,452,698
2019	255,241,278
2020	256,662,010
Total	1,758,096,626

Note: Estimates for 1990-1999 are bridged-race intercensal population estimates of the July 1 resident population. Estimates for 2000-2009 are revised bridged-race intercensal estimates of the July 1 resident population. Estimates for 2010-2020 are bridged-race Vintage 2020 postcensal estimates of the July 1 resident population. These estimates were prepared by the Census Bureau in collaboration with NCHS.

Obesity Prevalence

The Centers for Disease Control and Prevention Nutrition, Physical Activity, and Obesity: Data Trends and Maps tool (2022) was utilized to estimate data for those 18+ in the United States afflicted with obesity using a 95% confidence interval (see Table 2).

Table 2

US Adult Obesity Prevalence (2014-2020)

Year	Obesity Proportion	Obesity Point Estimate
2014	28.9	70,745,209.37
2015	28.9	71,407,644.19
2016	29.6	73,814,248.75
2017	30.1	75,698,427.39
2018	30.9	78,316,883.68
2019	31.4	80,145,761.29
2020	31.9	81,875,181.19

Note: Data was obtained using 95% confidence intervals reported from the Centers for Disease Control and Prevention which are estimates.

Confidence intervals work by using a sample of data (in this case, a sample of around 400,000 people per year from the Behavioral Risk Factor Surveillance System (2022)) to establish an interval – derived from the point estimate (our prediction) plus or minus a margin of error to generate our (confidence) interval – that we are 95% confident captures the true number of obese cases in the United States. In the realm of epidemiology and biostatistics, it is difficult to have definite numbers because it is unrealistic for researchers to review every single individual in the United States (as there are hundreds of millions). Instead, sample data are used to estimate population data, and the accuracy of the estimate increases as the sample size increases; given the large sample size of these confidence intervals (around 400,000 per sample year), there is a relatively small margin of error for this high level of confidence. For the purpose of this study, the point estimates were recorded and linear regression analysis was conducted to approximate predictions on future obesity prevalence data for adults in the United States.

Cardiovascular Disease

To determine the number of people who develop heart disease as a result of obesity, increased risk factor calculations were applied. Because obesity results in a 28% increased risk of heart disease (Lassale et al., 2016) and 7% of people will develop it naturally (US Institute of Medicine, 2011), 1.96 obese people should develop heart disease on average per 100 obese people (see Table 3).

Table 3

Cardiovascular Disease Attributable to Obesity Prevalence

Year	Comorbid Prevalence
2014	1,386,606
2015	1,399,589
2016	1,446,759
2017	1,483,689
2018	1,535,010
2019	1,570,856
2020	1,604,753

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

From the computed numbers, calculations were then done to determine the number of comorbid deaths based on the average proportion of people that die from heart disease vs. the total number of people with heart disease per year (see Table 4).

Using the CDCWONDER Underlying Cause of Death 1999-2020 tool, I was able to determine the total amount of adults who die of heart disease per year. The inputs for cardiovascular disease were ICD-10 codes: I00-I09, I11, I13, I20-I51; using all states; all levels of urbanization; ages 18 years +; all genders; all origins; all races; deaths on every day of the week; no designation for autopsy needed; and all places of death from 2014-2020.

Linear regression analysis was then conducted using a TI-nspire CX CAS to approximate predictions on future cardiovascular disease attributable to obesity prevalence and comorbid death for adults in the United States.

Table 4

Cardiovascular Disease Deaths Attributable to Obesity

Year	Comorbid Death
2014	49,645
2015	51,223
2016	52,587
2017	54,500
2018	56,640
2019	57,877
2020	62,192

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

Cancer

Many statistical calculations have already been done to determine cancer's link to obesity; it is estimated by researchers that 20% of cancers in the United States are caused by obesity (De Pergola & Silvestris, 2013). The prevalence of cancer caused by obesity was obtained by multiplying the number of adults diagnosed with cancer by this number for each year respectively (see Table 5).

Table 5

Cancer Attributable to Obesity Prevalence

Year	Comorbid Prevalence
2014	319,297
2015	326,678
2016	331,743
2017	340,263
2018	341,784
2019	349,522
2020	355,378

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

Table 6

Cancer Deaths Attributable to Obesity

Year	Comorbid Death
2014	114,251
2015	116,892
2016	118,704
2017	121,753
2018	122,297
2019	125,066
2020	127,161

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

It has also been determined that the rate of new cancer development in males and females on average is 442.4 per 100,000 and the rate of death is 158.3 per 100,000 (NCI, 2022) (158.3/442.4=35.7821% of developed cancers will ultimately cause death) per year. Using this proportion, the number of developed cancers attributable to obesity that will cause death for each year respectively was determined (see Table 6).

Linear regression analysis was then conducted using a TI-nspire CX CAS to approximate predictions on future cancer attributable to obesity prevalence and comorbid death for adults in the United States.

Type II Diabetes Mellitus

Research supported by grants from the National Institutes of Health and the American Heart Association support that between 30% and 53% (41.5% point estimate) of type II diabetes cases are caused by obesity (American Heart Association, 2021). Data for type II diabetes from 2014-2019 (the only available data) were obtained from the CDC Diabetes Atlas and linear regression was used to predict the values of prevalence for 2020 (see Table 7).

Table 7

Type II Diabetes Mellitus Prevalence

Year	Prevalence
2014	21,872,000
2015	23,161,000
2016	23,104,000
2017	23,048,000
2018	25,158,000
2019	23,419,000
2020	24,660,697

Note: Data was obtained from the CDC Diabetes Atlas. Prevalence for 2020 is an estimate resulting from linear regression analysis. Exact values would be impossible to quantify given the magnitude of this study.

The 41.5% attribution rate was then used to calculate the number of diabetes cases attributable to obesity (see Table 8).

Table 8

Type II Diabetes Mellitus Attributable to Obesity Prevalence

Year	Comorbid Prevalence
2014	9,076,880
2015	9,611,815
2016	9,588,160
2017	9,564,920
2018	10,440,570
2019	9,718,885
2020	10,234,200

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

Linear regression analysis was then conducted using a TI-nspire CX CAS to approximate predictions on future diabetes attributable to obesity prevalence for adults in the United States.

Depression

Obesity has been associated with a 55% increased risk of developing Major Depressive Disorder (Blasco et al., 2020) and approximately 6.7% of individuals will develop this condition on their own (Anxiety and Depression Association of America, 2022). Using these data, on average, 3.685 (.55 x .067) obese people out of every 100 obese people will develop depression as a result of their obesity (see Table 9).

Table 9

Depression Attributable to Obesity Prevalence

Year	Comorbid Prevalence
2014	2,606,960
2015	2,631,371
2016	2,720,055
2017	2,789,487
2018	2,885,977
2019	2,953,371
2020	3,017,100

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

Depression is also the primary contributor to suicide. Using percentages from CDC Data Briefs (2018) to determine depression prevalence computed with suicide numbers retrieved from the CDCWONDER database (2022), then applying that proportion of suicides vs depression cases to the depression attributable to obesity data allowed me to predict the number of comorbid deaths (see Table 10).

Table 10

Suicide Attributable to Obesity Prevalence

Year	Comorbid Death
2014	5,078
2015	6,159
2016	6,402
2017	6,294
2018	6,620
2019	6,634
2020	6,510

Note: Data was obtained after calculation with 95% confidence intervals reported from the Centers for Disease Control and Prevention and are estimates. Exact values would be impossible to quantify given the magnitude of this study.

Suicide prevalence was obtained through the CDCWONDER Underlying Cause of Death 1999-2020 tool with ICD-10 codes *U03, X60-X84, and Y87.0 and the conditions: all states; all levels of urbanization; ages 18 years +; all genders; all origins; all races; deaths on every day of the week; no designation for autopsy needed; and all places of death from 2014-2020.

Linear regression analysis was then conducted using a TI-nspire CX CAS to approximate predictions on future depression attributable to obesity prevalence and comorbid death for adults in the United States.

Results

United States Population (18)+

The equation for the linear regression line for United States population ages 18+ based on the given data was $\hat{y}=199960x+243157000$. Table 11 details outputs for the years 2021 and 2022.

Table 11

US (Adult) Population Estimates

Year	Population
2021	259,156,680
2022	261,156,640

Note: Obtained from linear regression equation $\hat{y}=199960x+243157000$ created for 2014-2020 data set.

Obesity Prevalence

The equation for the linear regression line for obesity prevalence ages 18+ based on the given point estimates was $\hat{y}=1977460x+68090700$. Table 12 details outputs for the years 2021 and 2022.

Table 12

US Adult Obesity Prevalence Predictions

Year	Prevalence
2021	83,910,380
2022	85,887,840

Note: Obtained from linear regression equation $\hat{y}=1977460x+68090700$ created for 2014-2020 data set.

Cardiovascular Disease

The equation for the linear regression line for cardiovascular disease ages 18+ attributable to obesity prevalence based on computed data was ŷ=38758.1x+133458. Table 13 details outputs for the years 2021 and 2022.

Table 13

Cardiovascular Disease Attributable to Obesity – Predictions

Year	Comorbid Prevalence
2021	1,644,640
2022	1,683,400

Note: Obtained from linear regression equation ŷ=38758.1x+133458 created for 2014-2020 data set.

The equation for the linear regression line for comorbid death ages 18+ based on computed data was ŷ=1964.36x+47094.6. Table 14 details outputs for the years 2021 and 2022.

Table 14

Cardiovascular Disease Deaths Attributable to Obesity – Predictions

Year	Comorbid Death
2021	62,810
2022	64,774

Note: Obtained from linear regression equation ŷ=1964.36x+47094.6 created for 2014-2020 data set.

Cancer

The equation for the linear regression line of cancer ages 18+ attributable to obesity prevalence based on computed data was ŷ=5856.14x+314385. Table 15 details outputs for the years 2021 and 2022.

Table 15

Cancer Attributable to Obesity – Predictions

Year	Comorbid Prevalence
2021	361,234
2022	367,090

Note: Obtained from linear regression equation ŷ=5856.14x+314385 created for 2014-2020 data set.

The equation for the linear regression line of comorbid death ages 18+ based on computed data was ŷ=2095.39x+112493. Table 16 details outputs for the years 2021 and 2022.

Table 16

Cancer Deaths Attributable to Obesity – Predictions

Year	Comorbid Death
2021	129,256
2022	131,352

Note: Obtained from linear regression equation ŷ=2095.39x+112493 created for 2014-2020 data set.

Type II Diabetes Mellitus

The equation for the linear regression line for type II diabetes ages 18+ attributable to obesity prevalence based on computed data was ŷ=162089.6x+9099560.

Table 17 details outputs for the years 2021 and 2022.

Table 17

Type II Diabetes Mellitus Attributable to Obesity – Predictions

Year	Comorbid Prevalence
2021	10,396,300
2022	10,558,400

Note: Obtained from linear regression equation $\hat{y}$=162089.6x+9099560 created for 2014-2020 data set.

Depression

The equation for the linear regression line of depression ages 18+ attributable to obesity prevalence based on computed data was $\hat{y}$=72869.4x+2509140. Table 18 details outputs for the years 2021 and 2022.

Table 18

Depression Attributable to Obesity – Predictions

Year	Comorbid Prevalence
2021	3,092,100
2022	3,164,960

Note: Obtained from linear regression equation $\hat{y}$=72869.4x+2509140 created for 2014-2020 data set.

The equation for the linear regression line of comorbid death ages 18+ based on computed data was $\hat{y}$=195.143x+5461.86. Table 19 details outputs for the years 2021 and 2022.

Table 19

Suicide Attributable to Obesity – Predictions

Year	Comorbid Death
2021	7,023
2022	7,219

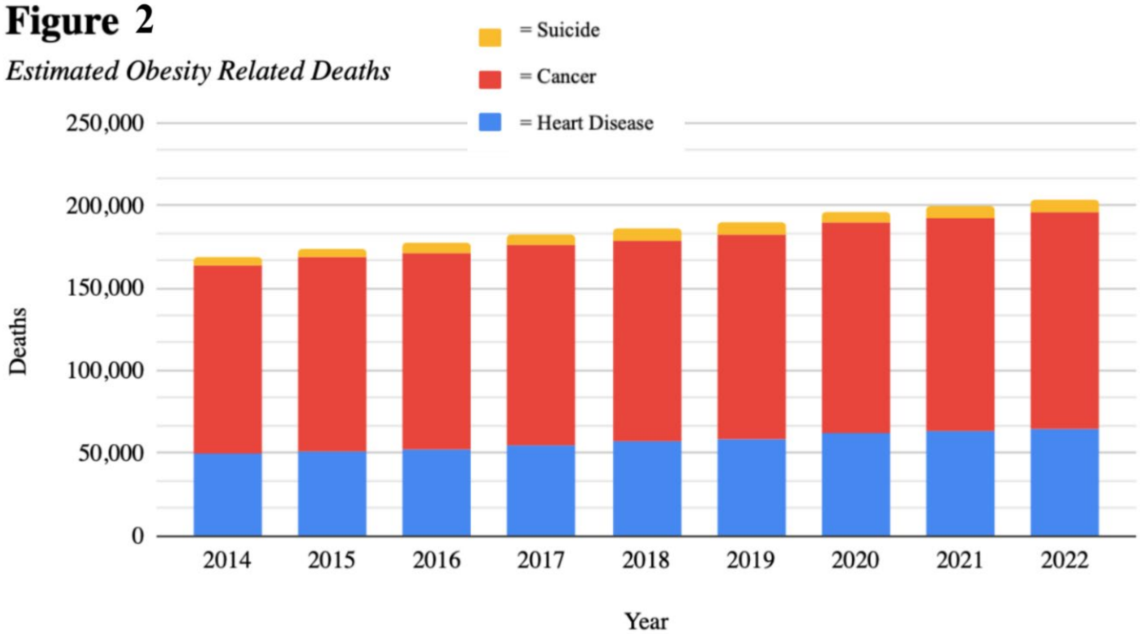
Note: Obtained from linear regression equation $\hat{y}$=195.143x+5461.86 created for 2014-2020 data set.

Trend Analysis

Given the demonstrated correlation between obesity and the studied comorbid conditions, obesity will account for a large number of deaths and contribute to the development of a large number of debilitating diseases in 2021 and 2022. All studied comorbidities increased from 2014-2020 and continued to increase in 2021 and 2022. Given these data, they are likely to continue to increase in the future. Based on these data, for the studied conditions, obesity has accounted for approximately 199,000 United States adult deaths in 2021 and will account for approximately 203,000 United States adult deaths in 2022 (see Figure 2).

Figure 2

Estimated Obesity Related Deaths



Note: Data was obtained from risk factor/proportion and linear regression calculation with 95% confidence intervals ($p \leq .05$) reported from the Centers for Disease Control and Prevention. Exact values would be impossible to quantify given the magnitude of this study.

This places obesity as the number 4 cause of death in America, below COVID-19 and obesity are included in this number, meaning the true number of obesity-related deaths is likely greater. In addition to deaths, obesity has and will continue to contribute to millions of cases of debilitating diseases in Americans per year – including but not limited to ~1.5 million (increasing yearly) cases of heart disease, ~ 360,000 (increasing yearly) cases of cancer, ~10.5 million (increasing yearly) cases of type II diabetes, and ~3 million (increasing yearly) cases of depression. While not all of these cases will result in deaths in 2021 or 2022, they all can develop into life-threatening conditions in the future or contribute to mortality in other ways such as reducing life expectancy, causing financial hardship and subsequent drop in socioeconomic class, or hindering the afflicted's ability to live their everyday life and respond to dangerous situations or injuries like a healthy individual would.

above miscellaneous unintentional injuries – and only a fraction of conditions linked to

Considerations

Some factors of this study should be considered as they may limit the accuracy of the results obtained in this research.

This study used the Centers for Disease Control's point estimates and confidence intervals for obesity prevalence which are not necessarily 100% accurate; however, the high confidence level of 95% ($p \leq .05$) means that any discrepancies that may be observed in the data are likely very close to the expected values of this study (due to the large sample size we have a relatively small margin of error).

There may be some cases where extraneous/confounding factors render risk factor and proportion calculations inaccurate. This study generalized average survival/death rates throughout all of the respective observed condition's cases when, in reality, conditions developed because of obesity likely have a higher death rate on average than if the condition was developed without obesity. Given this, any discrepancies in observed mortality are most likely greater than the expected mortality values in this study.

This study only accounted for some of the main comorbidities of obesity and did not account for every condition linked to obesity. Given that this research only reviewed obesity-linked cardiovascular disease, cancer, type II diabetes, and depression, the actual number of deaths and diseases caused by obesity is greater than the numbers portrayed in this study.

Finally, given that this is a trend analysis study based on approximations, the results are not exact and are instead simply a prediction based on statistical calculations of past data. The study was intended to synthesize and exemplify a clear link between obesity and a number of conditions known as more serious, with predictions of what the burden on United States public health may look like in the future. It is unrealistic and impractical to predict *exact* values as to the effects of obesity in the future, however, this study provided estimations and predictions based on a trend analysis methodology.

Outcomes & Additional Limitations

As of November 2022, the CDC, NIH, and other national health organizations have yet to report complete sets of obesity data for the United States for years post-2020 – or any data, for that matter, from 2022. While the predictive period of this research has almost passed, the predictions are still calculated from the most recent complete data sets available and still fill a gap in research as observed data has yet to be published. It remains unknown when observed data will be available for public consumption or if obesity data even has, indeed, been collected for 2021 and 2022 at this point.

The indefinite delay in the publishing of observed obesity prevalence from reputable sources is a major limitation in the determination of the ultimate accuracy of the methods and predictions effected by this study. While there are no complete data sets, however, some comparison can still be drawn between predicted values from this study and partial data sets from the CDC and US census for 2021.

The 2021 US census reports that there are ~258.3 million adults in the US, .331% below the predicted value of ~259.2 million from this study. The census also reports that in 2021 the US population grew at the slowest rate it ever has since its founding because of decreased international net migration, fertility, and increased mortality as a result of COVID-19. This accounts for the discrepancy in our observed vs. predicted numbers for population and will also have an effect on subsequent values such as obesity and comorbidity prevalence.

The most recent obesity data set from the CDC for 2021 leaves out the third largest state by population, Florida (US Census, 2021, *New Vintage 2021 Population Estimates*; US Census, 2021, *Age and Sex Tables*; CDC, 2021, *Prevalence of Self-Reported Obesity*), and many of the states lack sufficient data to even calculate obesity rates by demographic (CDC, 2021, *Adult Obesity Facts*). Using the CDC's reported national obesity prevalence for 2021 of 33.9% (omitting Florida from the calculation of the percentage), however, a plausible observed value of 87.6 million adults in the US with obesity was calculated (CDC, 2021, *BRFSS Prevalence & Trends Data*). This plausible observed value is ~4.35% above the expected value in this study of ~83.9 million, despite population growth also being lower than its expected value. As discussed briefly in the review of literature, a likely culprit of the disproportionate increase of obesity prevalence in expected vs. observed values may be attributable to sedentary lifestyles, socioeconomic instability, and mental health maladies caused and exacerbated by the COVID-19 pandemic. For the purposes of this study, however, a positive discrepancy between what was predicted to occur and what actually occurred only further exemplifies the dangers of obesity in America and its burden on our public health climate. Given that the actual rate of obesity may be ~4.35% higher than the rate predicted in this study for 2021, comorbid consequences also likely increased by another ~4.35% in addition to that which is detailed in this study. Likewise, from a trend analysis perspective, any subsequent years (including 2022) should see a compounded increase.

Conclusions

Obesity is a serious condition and given its major effects on United States adult public health for 2021 and 2022 should be a priority for health officials. Confined strictly to just the comorbid conditions researched in this study, obesity already contributes to hundreds of thousands of deaths per year and is linked to millions of debilitating comorbid conditions per year in the United States. Through linear regression analysis, it is estimated that obesity has accounted for approximately 199,000 deaths in 2021 and is predicted to account for even more in 2022, placing it as one of the leading causes of death in the United States. The prevalence of obesity is only rising and so are its consequences, making it one of the greatest threats to the United States population. While the resulting predictions of this research study are not absolutely definite due to a variety of limitations that should be considered (i.e., confidence intervals are estimations, there are some confounding and extraneous variables, the study did not account for all comorbidities, predictions are never exact, and the most recent *complete* data is from 2020), the study exemplifies a clear link between obesity and some of the world's most dangerous killers as well as makes predictions of quantifiable effects that this will have on United States adult public health. The predicted major annual pathological consequences of obesity – encompassing cardiovascular disease with respective mortality, cancer with respective mortality, type II diabetes mellitus, and depression with related suicide – on United States adult public health for 2021-2022 based on trends from 2014-2020 are immense and something that should be of greater concern to the American people and government.

References

American Heart Association. (2021). *Obesity contributes to up to half of new diabetes cases annually in the United States*. Retrieved April 28, 2022, from https://newsroom.heart.org/news/obesity-contributes-to-up-to-half-of-new-diabetes-cases-annually-in-the-united-states

Anxiety and Depression Association of America, ADAA. (2022). *Facts & Statistics: Anxiety and Depression Association of America, ADAA*. Facts & Statistics | Retrieved April 28, 2022, from https://adaa.org/understanding-anxiety/facts-statistics#:~:text=Major%20Depressive%20Disorder&text=MDD%20affects%20more%20than%2016.1,older%20in%20a%20given%20year

Barnes, A. S. (2011). *The epidemic of obesity and diabetes: Trends and treatments*. Texas Heart Institute journal. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3066828/

Blasco, B. V., García-Jiménez, J., Bodoano, I., & Gutiérrez-Rojas, L. (2020, August). *Obesity and depression: Its prevalence and influence as a prognostic factor: A systematic review*. Psychiatry investigation. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7449839/

Blaun, R. (2012, July 8). *The debate over the causes of obesity*. The New York Times. Retrieved from https://www.nytimes.com/2012/07/09/opinion/the-debate-over-the-causes-of-obesity.html

Bureau, U. S. C. (2021, December 21). *New Vintage 2021 population estimates available for the nation, states and Puerto Rico*. Census.gov. Retrieved November 6, 2022, from https://www.census.gov/newsroom/press-releases/2021/2021-population-estimates.html

Bureau, U. S. C. (2022). *Census Data*. Explore census data. Retrieved November 6, 2022, from https://data.census.gov/cedsci/table?q=adults%2Bper%2Bstate&t=Age%2Band%2BSex&tid=ACSST1Y2021.S0101&tp=true

Caffrey, M. (2020, July 30). *Diabetic amputations may be rising in the United States*. AJMC. Retrieved from https://www.ajmc.com/view/diabetic-amputations-may-be-rising-in-the-united-states

Centers for Disease Control and Prevention. (2009). Body mass index: Considerations for Practitioners. Atlanta, GA.

Centers for Disease Control and Prevention. (2018, February 13). *Products - data briefs - number 303 - February 2018*. Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/nchs/products/databriefs/db303.htm

Centers for Disease Control and Prevention. (2021). *BRFSS prevalence & trends data: Explore by topic*. Centers for Disease Control and Prevention. Retrieved November 6, 2022, from https://nccd.cdc.gov/BRFSSPrevalence/rdPage.aspx?rdReport=DPH_BRFSS.ExploreByTopic&irbLocationType=StatesAndMMSA&islClass=CLASS03&islTopic=TOPIC14&islYear=2020&rdRnd=5282

Centers for Disease Control and Prevention. (2021). *Centers for Disease Control US. Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory*. CDC.gov. Retrieved November 6, 2022, from https://www.cdc.gov/obesity/data/maps/2021/overall-obesity-prevalence-map-2011-2021-508.pdf

Centers for Disease Control and Prevention. (2021, February 18). *Obesity and cancer*. Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/cancer/obesity/index.htm

Centers for Disease Control and Prevention. (2021, June 7). *Defining adult overweight & obesity*. Centers for Disease Control and Prevention. Retrieved April 10, 2022, from https://www.cdc.gov/obesity/adult/defining.html

Centers for Disease Control and Prevention. (2021, September 30). *Adult obesity facts*. Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/obesity/data/adult.html

Centers for Disease Control and Prevention. (2022). *Bridged-race population estimates 1990-2020 request*. Centers for Disease Control and Prevention. Retrieved April 28, 2022, from https://wonder.cdc.gov/Bridged-Race-v2020.HTML

Centers for Disease Control and Prevention. (2022). *DNPAO data, trends and maps: Explore by topic*. Centers for Disease Control and Prevention. Retrieved April 28, 2022, from https://nccd.cdc.gov/dnpao_dtm/rdPage.aspx?rdReport=DNPAO_DTM.ExploreByTopic&islClass=OWS&islTopic=&go=GO

Centers for Disease Control and Prevention. (2022). *Frequently asked questions*. Centers for Disease Control and Prevention. Retrieved April 28, 2022, from https://wonder.cdc.gov/wonder/help/faq.html#8

Centers for Disease Control and Prevention. (2022). *Home - united states diabetes surveillance system*. Centers for Disease Control and

Prevention. Retrieved April 28, 2022, from https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html

Centers for Disease Control and Prevention. (2022). *Underlying cause of death, 1999-2020 about*. Centers for Disease Control and Prevention. Retrieved April 28, 2022, from https://wonder.cdc.gov/controller/datarequest/D76?stage=results&action=sort&direction=MEASURE_DESCEND&measure=D76.M3

Centers for Disease Control and Prevention. (2022, February 17). *Obesity, race/ethnicity, and covid-19*. Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/obesity/data/obesity-and-covid-19.html

De Pergola, G., & Silvestris, F. (2013). *Obesity as a major risk factor for cancer*. Journal of obesity. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3773450/

Institute of Medicine (US) Committee on a National Surveillance System for Cardiovascular and Select Chronic Diseases. (2011). *2 cardiovascular disease - NCBI bookshelf*. National Library of Medicine. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK83160/

Lassale C, Tzoulaki I, Moons K, Sweeting M, Boer J, Johnson L, Huerta JM, Agnoli C, Freisling H, Weiderpass E, Wennberg P, L van der A D, Arriola L, Benetou V, Boeing H, Bonnet F, Colorado-Yohar SM, Engström G, Eriksen AK, Ferrari P, Grioni S, Johansson M, Kaaks R, Katsoulis M, Katzke V, Key TJ, Matullo G, Melander O, Molina-Portillo E, Moreno-Iribas C, Norberg M, Overvad K, Panico S, Ramón-Quirós J, Saieva C, Skeie G, Steffen A, Stepien M, Tjønneland A, Trichopoulou A, Tumino R, T van der Schouw Y, Verschuren YMM, Langenberg C, Di Angelantonio E, Riboli E, Wareham NJ, Danesh J, Butterworth AS. (2018, June 1) *Separate and combined associations of obesity and metabolic health with coronary heart disease: a pan-European case-cohort analysis*, European Heart Journal, Volume 39, Issue 5, Pages 397–406, https://doi.org/10.1093/eurheartj/ehx448

National Cancer Institute. (2020). *Cancer statistics*. National Institutes of Health. (2020). Retrieved April 28, 2022, from https://www.cancer.gov/about-cancer/understanding/statistics

National Cancer Institute. (2022). *NCI Dictionary of Cancer terms*. National Institutes of Health. (2022). Retrieved from https://www.cancer.gov/publications/dictionaries/cancer-terms/def/risk-factor

O'Callaghan, T. (2009, November 18). *Obese and unaware: Can you be too comfortable with your body size?* Time. Retrieved from https://healthland.time.com/2009/11/18/obese-and-unaware-can-you-be-too-comfortable-with-your-body-size/

Powell-Wiley, T. M., Tiffany M. Powell-Wiley, Poirier, P., Paul Poirier, Burke, L. E., Lora E. Burke, Després, J.-P., Jean-Pierre Després, Gordon-Larsen, P., Penny Gordon-Larsen, Lavie, C. J., Carl J. Lavie, Lear, S. A., Scott A. Lear, Ndumele, C. E., Chiadi E. Ndumele, Neeland, I. J., Ian J. Neeland, Sanders, P., … On behalf of the American Heart Association Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Epidemiology and Prevention; and Stroke Council. (2021, April 22). *Obesity and cardiovascular disease: A scientific statement from the American Heart Association*. AHA Journals.

Retrieved from https://www.ahajournals.org/doi/10.1161/CIR.0000000000000973

Puhl, R. M., & Heuer, C. A. (2010, June). *Obesity stigma: Important considerations for public health*. American journal of public health. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2866597/

Quiñones-Ossa, G. A., Lobo, C., Garcia-Ballestas, E., Florez, W. A., Moscote-Salazar, L. R., & Agrawal, A. (2021, January 4). *Obesity and stroke: Does the paradox apply for stroke?* Neurointervention. Retrieved from https://neurointervention.org/journal/view.php?number=308

Ritchie, H., Spooner, F., & Roser, M. (2018, February 14). *Causes of death*. Our World in Data. Retrieved from https://ourworldindata.org/causes-of-death

Robert H. Shmerling, M. D. (2020, June 22). *How useful is the body mass index (BMI)?* Harvard Health. Retrieved from https://www.health.harvard.edu/blog/how-useful-is-the-body-mass-index-bmi-201603309339

Romero-Corral, A., Somers, V. K., Sierra-Johnson, J., Thomas, R. J., Collazo-Clavell, M. L., Korinek, J., Allison, T. G., Batsis, J. A., Sert-Kuniyoshi, F. H., & Lopez-Jimenez, F. (2008, June). *Accuracy of body mass index in diagnosing obesity in the adult general population*. International journal of obesity (2005). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2877506/

Schneider, A., Hommel, G., & Blettner, M. (2010, November). *Linear regression analysis: Part 14 of a series on evaluation of Scientific Publications*. Deutsches Arzteblatt international. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2992018/

Schober, P., & Vetter, T. R. (2020). Linear regression in medical research. *Anesthesia & Analgesia*, *132*(1), 108–109. https://doi.org/10.1213/ane.0000000000005206

Shoham, D. A., Hammond, R., Rahmandad, H., Wang, Y., & Hovmand, P. (2015, January 13). *Modeling social norms and social influence in obesity - current epidemiology reports*. SpringerLink. Retrieved from https://link.springer.com/article/10.1007%2Fs40471-014-0032-2

U.S. Department of Health and Human Services. (2012). *What causes obesity & overweight?* Eunice Kennedy Shriver National Institute of Child Health and Human Development. Retrieved from https://www.nichd.nih.gov/health/topics/obesity/conditioninfo/cause

U.S. Department of Health and Human Services. (2022, March 24). *What are overweight and obesity?* National Heart Lung and Blood Institute. Retrieved April 10, 2022, from https://www.nhlbi.nih.gov/health-topics/overweight-and-obesity

Valderas, J. M., Starfield, B., Sibbald, B., Salisbury, C., & Roland, M. (2009). *Defining comorbidity: Implications for understanding health and health services*. Annals of family medicine. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2713155/

Willadsen, T. G., Bebe, A., Køster-Rasmussen, R., Jarbøl, D. E., Guassora, A. D., Waldorff, F. B., Reventlow, S., & Olivarius, N. de F. (2016, June). *The role of diseases, risk factors and symptoms in the definition of multimorbidity - A systematic review*. Scandinavian journal of primary health care. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4977932/

World Health Organization. (2022). Obesity. World Health Organization. Retrieved April 10, 2022, from https://www.who.int/health-topics/obesity#tab=tab_1 Yale University. (2022). Linear Regression. Yale University. (2022). Retrieved from http://www.stat.yale.edu/Courses/1997-98/101/linreg.htm

Zhu, J., Su, X., Li, G., Chen, J., Tang, B., & Yang, Y. (2014, October 27). The incidence of acute myocardial infarction in relation to overweight and obesity: A meta-analysis. Archives of medical science: AMS. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4223131/

Practices and Beliefs of Superstitions in Nevada's Scottish Diaspora

Alexandra Zoellner[1]
[1]Department of Anthropology, University of Nevada, Reno

Abstract

Do members of the Scottish diaspora, those of Scottish descent outside of Scotland, still practice traditional Celtic superstitions? Superstitions are defined as cause-and-effect practices based on a belief that if x happens, y will be the result. The purpose of this research is to identify whether or not traditional Celtic superstitions are passed on in the Nevada Scottish diaspora, and if any, which ones are passed on and which are not. The results signify how strongly members identify with their heritage, and what their heritage means in defining who they are. The main superstitions kept in the Nevada diaspora are ancient ones, such as counting Corvids, knocking on wood, and acting upon second sight premonitions. Scottish diaspora members in Nevada express fluid superstition, defining themselves differently and practicing superstitions for different reasons.

Introduction

In the Nevada area of the United States, one of the prominent Celtic diasporas is those of Scottish descent. A diaspora is a "dispersion of a people, language, or culture that was formerly concentrated in one place" (DePaul University, 2022). The Scottish diaspora in Nevada is a group of people of Scottish heritage whose families were separated from Scotland, and who formed a new cultural community. This research aims to discern the practices and beliefs of superstitions in Nevada's Scottish diaspora. For some, superstitions are an accepted part of everyday life. In this research, "superstition" is considered a mode of agency in the broader reality that surrounds us, using cause-and-effect ideas to support the chance of the desired outcome (Goodall, 2010, p. 308). Superstitions are cultural. The idea of superstitions is they are not just the mere action, but rather include a belief system (Goodall, 2010, p. 309). "Superstition" is an agreed upon term with the participants of this research. This ethnography strived to observe and understand the superstitions that the Scottish diaspora practices. Practices such as superstitions are a way for one to express one's heritage and form an identity.

How a culture engages with traditional practices, such as ancient Druid practices in the Scottish context, is a window into not only how the culture has changed over time but how the culture will continue to change and maintain its traditions. Culture change is especially of interest in diaspora communities, as many feel the pressures of losing ties to one's cultural identity of the homeland (Ergashev & Farxodjonova, 2019). Change through globalization is regarded as neutral, as cultures experience what they see as positive and negative outcomes. However, the negative outcome of loss of traditions is great. Cultures are known to attempt to save their heritage from the total loss at whatever cost, despite benefits of globalization (DeSilvey & Harrison, 2020, p. 3). The total loss of heritage is to lose one's identity in their culture. It is vital for the older generations to pass on this cultural knowledge and identity, as those belonging to traditional culture face worry about the continuation of practices (Cwik et al., 2019). Superstitions are part of everyday life, which is why they are important to cultural identity. It is believed superstitions "form part of ceremonies considered to be rites of passage- birth, marriage, death- while others are essential items in festivals…as they have been for centuries" (Livingstone, 2021, p. 7). Superstitions may also have a place in the everyday lives of the Scottish diaspora members.

There are specific reasons why Scots left Scotland and settled into diaspora communities. They left due to various push and pull factors, reasons pushing people out of their home and reasons pulling them to other locations. Bueltmann, a scholar of Scottish history, identifies four main reasons: demographic pressures, standards of living, occupational changes, and urbanization (Bueltmann et al., 2013, p. 74). This would lead many Scots to the Americas between the early 1700s and the late 1770s and form diasporas. Newton (2014) explains, "Some Gaelic emigrants in the eighteenth and nineteenth centuries- and often from the same locale- reconstituted themselves in cohesive communities forming a strong sense of identity" (p. 136). Communities form a distinct culture with their diaspora. An example of this is with the Scottish diaspora in Glengarry, Ontario. After immigrating to this region of Canada, they emphasized their identity on being "Gàidhealtachdan," or "Scottish emigrants" (Newton, 2014, p. 136). A new culture formed. Few Scottish diaspora communities identify as being fully integrated with the traditional folktales. Newton (2014) states that cultural conformity has made it so that Nova Scotia, a province in Canada, is the last remaining diaspora that has fully kept and integrated aspects of the traditional folk culture from Scotland (p. 150). Like other diaspora cultures in the Americas, Scots were part of the western expansion across the United States. Bueltmann (2013) indicates Scots were enticed by the discovery of precious metals and formed diasporas in Nevada, Colorado, Wyoming and California to work in mines" (p. 182). These diasporas remain, leading this research to specifically study superstitions and practices in Nevada, related to traditional Celtic beliefs.

Based on the idea people continue cultural traditions, superstitions may be prevalent in the lives of Scottish diaspora members. James Napier, a Scot who compiled accounts of traditional Scottish folklore in the late 1800s, suggested that superstitions practiced in the 1800s were not that different from the ones practiced in ancient times. He wrote, "There is a close family likeness in this matter of superstition between now and long ago, and this state of matters will continue so long as knowledge is physical" (Napier, 1879, p. 15). With this idea in mind that traditions are passed on in the written form, as was the goal of Napier's compilation, the process of passing down would continue. He suggested people then, and today, are no less superstitious than the ancestors. Many members of the Nevada Scottish diaspora practice traditional Scottish superstitions, regardless of supernatural experiences, such as psychic abilities, traditional beliefs, or interactions with the Fae. However, these beliefs and practices of traditional superstitions are becoming more common and accepted in younger generations. These superstitions surround ancient beliefs, the Fae, and second sight. Superstitions and practices do not always align perfectly. Just because a person does not define themselves as superstitious, does not mean that they hold no beliefs in the supernatural. Beliefs and practices surrounding superstitions and the metaphysical are fluid. Practicing superstitions relate to a larger issue, where members of a cultural community can create a strong sense of identity and camaraderie with others and their heritage.

Methodologies

The operational approach for this research is cultural ethnography. Ethnography involves the researcher studying a specific community through interacting with the community itself, taking an anthropological approach of studying a culture through its lens (Caulfield, 2020). Whether or not a participant is concluded as superstitious is dependent on if they considered themselves to be superstitious. Ethnographic qualitative data were analyzed and collected. Quantitative data such as the number of participants who describe themselves as superstitious were also used for analysis. All participants consented to their responses being analyzed and published.

A bottom-up approach was taken, starting with the question of whether or not Scottish diaspora members practice traditional superstitions, literature research and interviews were conducted, data were gathered, and patterns were analyzed to form a conclusion (Rahman Shakil, 2019). Participant questions were generated after literature review on the topic of Celtic superstitions and beliefs. After analysis of each interview, a thematic analysis was used to identify reoccurring themes (Hvas Mortensen, 2020), including counting Corvids (a family of birds), knocking on wood, second sight, and cultural identity through community and belief. Of the ten participants interviewed, four were below 40 years of age (three females and one male) and six were over 40 years of age (three females and three males). Participants were contacted online, either by email or Facebook Messenger after a recruitment post was made to the Nevada Society of Scottish Clans (NSSC) Facebook group. All interviews were conducted on Zoom due to concerns of Covid-19 from July through October, 2021. To remain anonymous, each participant decided on a pseudonym. Otter.ai was used to help transcribe the verbal interviews into written form for analysis. Participants were asked a series of ten questions from the interview guide and an open conversation on Scottish superstitions followed. The ten questions were as follows:

1. Would you define yourself as superstitious?
2. Were you raised with any superstitions or specific practices in your family, be that from a parent, guardian, grandparent, et cetera?
3. What is your relationship with Scottish culture? Are you of Scottish descent, do you simply have a passion for the culture, or both?
4. Are there any superstitions or general practices that you partake in commonly? If so, do you believe these to have Celtic origins?
5. Do you have any superstitions or beliefs unrelated to Celtic culture that you follow?
6. Have you ever knocked on wood? If so, how do you view it? Do you view it as habit or tradition, or do you fully believe in its power?
7. Have you attended a Robert Burns Dinner? If so, how do you view the custom and practice regarding the candle in the opening ceremony?
8. Do you have a favorite piece of Scottish folklore, customs, belief, or superstition?
9. Would you be interested in learning more about Scottish superstitions, customs, and folklore in the future?
10. Do you believe that the Scottish diaspora (those of Scottish descent outside of Scotland) have a strong connection to their Celtic roots?

Participants were directly asked about knocking on wood, but topics of Corvids and second sight came up in conversation. Zoom interviews were recorded with participant permission. Before and after interviews, literature regarding Scottish superstitions was reviewed.

The next sections are ordered by topics of superstitions: Corvids, the Fae, and second sight. Regarding counting Corvids, participants gave examples of what specific Corvids (ravens, crows, or magpies) they associated with the superstition and whether or not they practiced it. For the Fae section, participants were asked if they knocked on wood and how they interpreted it. For participants with second sight experiences, participants were asked if they had familial or personal experiences with it, examples of such, and how they responded to it. Finally, each participant ranked themselves as superstitious, superstitious to a point, or not superstitious.

Traditional and Ancient Celtic Superstitions: Counting Corvids

Superstitions found in the Scottish diaspora derive primarily from Druidism, a religious system and philosophy practiced by the Druids, who resided in the Celtic countries during ancient times. In pre-Christian Scottish practices, Druidism was the primary belief (Wright, 1924). It was more than religion; it was the lifestyle of the ancient Celts. Changes in culture and religion have altered the practices, such as change with the spread of Christianity (Napier, 1879). However, Celts still practice some ancient traditions. Revival movements have even brought interest back into the ancient beliefs and practices, as people see examples of ancient practices and superstitions in popular culture (Edensor, 2002). One of the participants, whom I will call Maud, is a practicing Druid. Specifically, she distinguished that she practices Ancient Druidism rather than the modern form of Druidism. While Druidism is noted as a Celtic religion, Maud is more involved with practicing the spiritual aspect of Druidism. Through this, she speaks with guardian spirits, primarily that of ravens and wolves. She explained her practice:

> I consider my spiritual belief to be that of Ancient Druidism. Specifically, the “ancient” because people confuse it with New Age Druidism, which is different. New Age has aspects of other groups in it as well. You know, Druidism was the Celtic religion. Where I’m not following the religion, I'm just following the spirituality of it. So, I speak with ancestor spirits.

An important aspect of Druidism that Maud follows is respect for nature. Animals of different kinds are also held in high regard, relating to beliefs and superstitions involving animals. Napier noted in his collection, “Seeing magpies before breakfast was a good or bad omen according to the number seen up to four…One bodes grief, two’s a death, three’s a wedding, four’s a birth” (Napier, 1879, p. 113). This superstition surrounding counting magpies in Scotland acted as a type of foretelling of events that would occur. Maud acknowledged personally practicing this superstition at times.

Another participant whom I will call Maeve, brought up: “I think that crows had a significance to Celtic superstitions. The number of crows seen determined the outcome. Each one had a different meaning.” Maeve is referring to this same counting superstition, but with crows instead of magpies. The difference in bird could be due to the geographical location of superstitious practices. Crows are common across the British Isles except for Ireland, where populations are sparse (Shersby, 2021). This may lead Irish peoples or those of Irish-descent to practice the superstition with magpies rather than crows. If a particular bird is not common to one region, a different bird may be used.

Andraste, another participant, also brought up this superstition with ravens, instead of crows or magpies. Maud also acknowledged she practiced this superstition with ravens, as well as magpies. Regardless of which is the original superstition, whether it is ravens, crows, or magpies, all versions hold merit as a connected superstition with the same concept at heart: the number of birds present signify a different outcome. In fact, all three birds are related because crows, ravens, and magpies are all Corvids, a family of birds (Shersby, 2021). These birds share similar physical features, which is a proposed reason for why all three exist in the superstition.

Divining, knowing future events, is an ancient practice which often leads to superstition. Out of the ten participants, Maud, Maeve, and Andraste are the only three that practiced the superstition of counting Corvids, whether magpies, crows, or ravens. Maud, Maeve, and Andraste are all females in their early twenties. Although Maeve expressed a belief in this divining technique to some extent, she described herself as superstitious to a point. Maud and Andraste put a stronger emphasis in belief with the superstition, and described themselves as superstitious. Members of the diaspora community may practice particular techniques and superstitions as part of their culture, but that does not necessarily mean that they define themselves as superstitious. Superstitions can be part of habit and everyday practices within a culture (Napier, 1879). Traditional and ancient superstitions, derived from Druidism, are a starting point for analyzing superstitious practices in the Scottish diaspora. Superstitions become more complex when supernatural beings are involved, such as the Fae.

The Fae

Popular culture has brought traditional beliefs and superstitions to the knowledge of modern-day people. This includes the knowledge of supernatural beings, especially the Fae, better known today as fairies. However, the ideas surrounding the Fae are not necessarily the same as they once were in their Celtic origins (Gunnyon, 1877). Where people today may idealize the Fae as precious dainty creatures with "good" magic, this was not always the case. Celts described the Fae as "a less amiable race…even those of England, whose characters were modified in the popular kind by the airy and graceful fancy portraits of Shakespeare, Drayton, and Mennis" (Gunnyon, 1877, p. 298). Traditional Celts viewed the Fae as repulsive beings or nature spirits that caused mischief and trouble for the people. Pop culture misconstrued this belief in Shakespearean plays, the pop culture of the time. Gunnyon (1877) emphasized that despite these changes in perception and portrayal, the Fae were still not viewed as kind creatures by Scots and other Celtic peoples.

Beliefs surrounding the Fae are common to traditional and modern superstitions because they appear quite frequently and prominently within Celtic folklore. This is especially the case when it comes to knocking on wood, which has Celtic origins (Zhang et al., 2013, p. 1172). The superstitious practice is that the Fae and other nature spirits lived in trees. Knocking on the trees was seen as a sign of gratitude for the beings and as a way to ensure protection from the spirits rather than the mischief that they would cause (McMahon, 2022). Particularly in Ireland, the Irish would knock on wood in order to show gratitude to leprechauns, which are considered a type of Fae (Zhang et al., 2013, p. 1172). Despite its origins, this superstition is known throughout western culture regardless of one's heritage. Participants were asked what they thought of the superstition and how exactly they viewed the practice of it. Out of the ten participants, nine of them knocked on wood. The answers varied, with most participants explaining that they do knock on wood in some capacity. Whether this was out of habit, positive thinking, or full belief in the Fae depended on the individual.

The one participant who did not knock on wood, Sigurd, did not define himself as superstitious. The other participants did knock on wood to varying degrees, whether or not they believed in the Fae. For those that did not express belief in the Fae but still knocked on wood, the participants explained different reasons for participating in the superstition. Bonnie answered that she knocks on wood often as a caution. To her, she does not want to risk the situation going awry. This is similar to Murdock's answer. He knocked on wood, but did not do it necessarily out of belief or habit. While he was open to the possibility of the Fae's existence, he did not knock on wood for them. He explained the act as a way of "positive thinking." In this way, both Bonnie and Murdock, an older woman and a young adult male, knock on wood in order to create good energy surrounding the situation. Murdock explained: "I do it more out of, I guess, just positive thinking. So, it's more that I'm making a conscious effort for it not to happen versus believing that the wood has given power that the bad things won't happen." Archibald, an older male participant, knocked on wood sometimes but did it as a comment on the situation, rather than superstition or habit. He does this to express how much he does not want the situation to go backwards.

Another participant who is a middle-aged female, known as Iona, knocked on wood, but explained that her practice had nothing to do with the Fae, citing her religious background as Christian. She noted that by not knocking on wood, one might tempt the devil into messing with the situation. This belief regarding the devil in place of the Fae for knocking on wood originates from the time of Christianization in Scotland. The practice was kept, but the beliefs and supernatural figure changed (Zhang et al., 2013, p. 1172). Finally, another middle-aged female participant of a Christian background known as Celtmom expressed that she knocked on wood frequently, but only out of habit.

The four remaining participants did express belief in the Fae, but they all knocked on wood for slightly different reasons. Maeve, Maude, and Andraste are all young adult females, and Paisley is an older male. The first participant, Maeve, expressed belief in the Fae but knocks on wood out of habit and acknowledgement for the traditional belief and practice. Maud explained, as a Druid, that she definitely believes in the Fae. Still, she mostly leaves the Fae alone in her practice and tries to avoid phenomena having to do with the Fae. She knocked on wood and viewed it as a way to "properly conduct oneself around the Fae." While she mainly wanted to leave the Fae alone, she viewed knocking on wood as a type of respect and a habit:

> I think it's more of a habit. It's a habit and partially a way to show my respect, just in case. But there are times where I use it in the sense of using this to show my respect towards the Fae and they don't mess with me. I knock on wood out of respect, but it doesn't fully keep them away.

Maud's response shows how beliefs surrounding superstitions can be rather complex. While she does believe in the Fae, and more importantly the power that they have, she has multiple reasons for practicing the knocking on wood. She does it out of respect, but more than anything the action itself is still a habit. Maud does not want the Fae to disrupt her in any way and so she habitually knocks on wood. However, she does not believe knocking on wood entirely keeps the Fae away.

Paisley, an older male participant, stated that while he is open to belief in the Fae, knocking on wood was a type of habit but also with some belief in the metaphysical beings. Finally, Andraste knocked on wood and believed in the Fae, but explained that she had no reason to believe it keeps the Fae from interfering.

These various answers show the diverse nature of belief and practice in regards to traditional Celtic superstitions. Different individuals of the Scottish diaspora have belief or disbelief in varying levels according to whether or not they practice knocking on wood. Further, they had different reasons for why they knocked on wood, regardless of belief or disbelief in the Fae. Superstitions and practices do not always align perfectly. Beliefs and practices surrounding superstitions and the metaphysical are fluid. Demonstrated in further sections, the belief in the supernatural does not entirely correlate with whether or not participants have had other experiences with the supernatural or metaphysical. Community members, regardless of whether or not they believed in the Fae or knocked on wood, knew the stories and associations of these creatures. Older participants such as Archibald, Paisley, and Bonnie noted learning about the beliefs and superstitions from their parents or grandparents. However, younger participants such as Maud, Maeve, and Andraste learned about the beliefs from the internet, books, and personal research. Now, Celtic parents rarely raise their children with the stories of their heritage. Younger generations that may not have learned from their parents learn about them from other means. While the practices of superstitions may not necessarily be passed on from generation to generation, younger generations are still learning and practicing. While the reasoning for continued practice is different than what was originally proposed, being that generations are not necessarily passing down the beliefs, the hypothesis of continued practice and fluid belief regarding practice is supported.

Second Sight

Seeing the future or having the ability of divining is something that exists in many cultures, but a particular phenomenon of it exists in Scottish culture known as “second sight.” Second sight is defined as an ability that “manifests itself through the person having spontaneous vivid imagery through different senses which apparently gives information about a spatially or temporarily distant event” (Cohn, 1999, p. 351). There are a few theories as to why this cultural phenomena exists, one theory citing the Fae. Gunnyon (1877) wrote of a man named Thomas who traveled to the Fae realm and “he received the gift of prophecy, of foretelling with certainty future events in the history of Scotland” (p. 308). This is one literary explanation of why some Scots are able to see the future or sense future events, but it is not widely accepted (Cohn, 1999). Largely, the reason as to why is unknown. This ability to perceive future events is not unique to Scottish culture, but the concept of “second sight” as hereditary is unique (Cohn, 1999, p. 351). Not every member of the family will have the ability, or may develop it at a later time. In my study with ten participants, three participants claimed to have second sight run in their family. More importantly, those with second sight experiences do not necessarily describe themselves as superstitious, and second sight can lead to the practice of superstition. When one believes something will occur, they act in a certain way in order to achieve a certain outcome.

Bonnie, who claimed to be superstitious, explained that she was in one of these second sight families, but she did not have this ability. She explained that the second sight appeared generational in her family, with her sister having the gift:

> My dad had my grandma talk to my sister about it. She thought she was going crazy or she was just, you know, something was wrong- and so my grandma explained that's perfectly natural and that's been continued on generation after generation after generation in our family.

Although Bonnie did not inherit second sight, this was prominent in her family on her father’s side. People with second sight have not widely discussed it out in the open, even within Scottish culture. Others have not always been open to supernatural phenomena (Jenkins, 2004). Although Bonnie mentions that her sister struggled with accepting her gift when she was younger, her family was more or less open to discussing second sight when necessary. This is not always the case for families with second sight, as Bonnie elaborates when discussing a family friend that also had it. She explained the lack of acceptance:

> I know I had a family friend almost 25-30 years ago, and he was mentioning his Scottish background and how he had the second sight. This was strange for me because I'd only heard of females having it. But talking with him about it, it was pretty interesting and a lot of the way he

> was treated by his own family had been not so well. And so, they tried to tamper it down.

Some Scottish families with second sight are open to discussing the phenomena within the family, but other families do not do this in the same way. Times of fear within a culture can suppress knowledge of supernatural events, as many people fear the treatment they may endure from others (Jenkins, 2004). Supernatural hysteria has led people to treat others unjustly, which keeps people from openly discussing the supernatural (Jenkins, 2004). This contributes to the lack of public or general knowledge on second sight. Despite this, the phenomenon still occurs in certain families of Scottish heritage.

Andraste, a young adult participant, also described second sight in her family with strong intuition. She noted that her mother and herself have always had a strong sense of intuition. She introduced this with the example: “My mom would tell me ‘Oh, you're not allowed to walk to school alone’ when I was in elementary school, and that same day some kid was kidnapped from my school.”

While second sight and other moments of intuition can occur with nonextreme events, noted ones are situations where the stakes were high. In the example Andraste gave, this is a superstitious reaction. Her mother sensed that something would happen, she acted upon it by walking Andraste to school, and the result is that Andraste was safe. Andraste followed up with another specific story about her mother’s intuition. Her family attended the 2011 Reno Air Races, where a deadly crash occurred. Andraste recounted:

> My parents were in special seats at the races and my mom was like, “Oh, I have a bad feeling. Let's leave,” and they left, and the plane crashed five minutes after they left, right where they were sitting.

If her mother had not had that strong sense of intuition, or second sight, Andraste admitted that she would have lost her parents. This is another example of second sight leading a person to engage with a superstitious act. Andraste’s mother sensed something bad would occur, she made the family leave, and they were kept safe from the crash as a result of the action. This strong sense of second sight runs in her family. While Andraste is not entirely sure if her heritage is Scottish or another Celtic culture, her stories and hereditary intuition are similar to that of the Scottish second sight. She feels strongly connected to the Celtic culture.

Finally, Iona is a middle-aged participant who experiences second sight. During the interview, she described multiple of her family members having second sight: her father, herself, and her daughter. For the most part, the second sight was always something she acknowledged in her family, but it was something seldom discussed openly. This is for reasons similar to what Bonnie mentioned with her family friend. An open discussion on second sight could result in a lack of acceptance or even persecution from others (Jenkins, 2004). Iona's family members with second sight mainly kept the secret ability between them. Iona’s father guided her through these times. On one particular occasion, they shared a dream:

> My father and I shared dreams when I was a teenager. Having the same dream multiple times, and we discussed it, and then by changing an aspect to keep it from happening. So by going into the details [of the dream], we changed it. We failed to purchase one specific item purposefully in hopes of changing the course so that the dream wouldn't become reality.

Although Iona did not wish to go into details of this second sight dream for personal reasons, she expressed that it was a very dangerous situation related to an item that they had planned to purchase. By deciding not to purchase that item, Iona and her father made the call to trust the shared dream and to save Iona’s life. This is a superstitious reaction. Although this was a shared moment between Iona and her father, their larger family did not discuss second sight. When I asked Iona about this, she answered that as a strongly Christian family, second sight was not talked about. To discuss it further in the religious context of the family would be to put oneself at potential risk. People are often fearful of what they may not understand (Jenkins, 2004). For Iona and other members of the Scottish community with second sight, a lack of discussion keeps them safe. With that, they find a sense of identity and community with others who have second sight in the Scottish diaspora.

Having interviewed three separate participants that expressed familial experiences with second sight, a misconception would be that all three of these participants are superstitious. Although superstitions heavily contain aspects of the supernatural, and that second sight actively leads to superstitious practices, not everyone who has supernatural experiences consider themselves to be superstitious. When I asked participants whether or not they would define themselves as superstitious, I received mixed answers. Bonnie explained that she is superstitious, Andraste admitted that she is highly superstitious, and Iona did not consider herself to be superstitious. Although they all come from families with extensive histories in second sight and intuitive abilities, this did not have a clear effect on whether or not they thought of themselves as superstitious. Still, all three noted instances of superstitious practice as a result of second sight. Superstitious practices are dependent of the individual. While not every member of the Nevada Scottish diaspora shares second sight, multiple community members realized they are not alone with their gifts. This brought about a change from feeling isolated to feeling unity within the diaspora through identity.

Conclusion and Discussion: Identity through Superstition

In short, the Scottish diaspora in the Nevada area is not necessarily superstitious, but superstitions are important aspects of cultural identity and community. Many members of the Nevada Scottish diaspora practice traditional Scottish superstitions, regardless of supernatural experiences such as psychic abilities, traditional beliefs, or interactions with the Fae. Even if a member engages in a superstition does not mean they define themselves as superstitious. Practices and superstitions do not always align perfectly. However, these beliefs and practices of traditional superstitions are becoming more common and accepted by younger generations, seen through Maud, Maeve, Andraste, and Murdock’s openness to the Fae. Just because a person does not define themselves as superstitious, does not mean that they hold no beliefs in the supernatural. Beliefs and practices surrounding superstitions and the supernatural are fluid. Out of the ten participants, four defined themselves as superstitious, two defined themselves as superstitious to a point, and four did not define themselves as superstitious. Whether or not a participant engaged in superstitions, or even considered themself to be superstitious, was dependent on the individual. Participants defined themselves on variable levels of superstition. Bonnie, Maud, Paisley, and Andraste considered themselves as superstitious. Maeve and Murdock explained that they are superstitious to a point. Meanwhile Sigurd, Archibald, Iona, and Celtmom did not define themselves as superstitious.

Maud, Maeve, and Andraste all engaged with traditional Celtic superstitions from Druidism, but their level of superstition varied. Maud and Andraste considered themselves superstitious, though Maeve defined herself as superstitious to a point.

These three are the only members that practiced the superstition of counting Corvids, whether magpies, crows, or ravens. Older participants did not engage with traditional superstitions, and Maud, Maeve, and Andraste did not learn the superstitions from their families. They learned about them on their own, through books and the internet, citing a revival of interest in culture.

When participants were asked about knocking on wood, nine out of ten participants engaged with the superstition. While knocking on wood has traditional origins, it has a larger existence in Western superstition as a popular practice (McMahon, 2022). Participants had multiple reasons for knocking on wood. Sigurd, the one participant that did not knock on wood, did not define himself as superstitious. Archibald knocked on wood as a comment on the situation, and did not define himself as superstitious. Iona knocked on wood because she believed otherwise the devil will interfere, but did not define herself as superstitious. Celtmom, while also Christian, did not define herself as superstitious, but knocked on wood out of habit. Murdock knocked on wood out of caution, and defined himself as superstitious to a point. Maeve believed in the Fae, knocked on wood out of habit, and defined herself as superstitious to a point. Bonnie knocked on wood as a caution, and defined herself as superstitious. Maud knocked on wood out of respect for the Fae, and defined herself as superstitious. Paisley knocked on wood out of habit, and defined himself as superstitious. Lastly, Andraste believed in the Fae and knocked on wood, but did not believe the practice would truly keep the Fae away, and defined herself as superstitious. While the beliefs and practices of superstitions may not necessarily be passed on from generation to generation, younger generations are still learning and practicing, as seen with Maud, Maeve, Andraste, and Murdock, all in their early twenties. While the reasoning for continued practice is different than what was originally proposed, being that generations are not necessarily passing down the beliefs, the hypothesis of continued practice and fluid belief regarding practice is supported. The majority of participants learned the practice from their families, but Maud, Maeve, and Andraste learned about the belief from their own research, and believe in the Fae.

Only three out of the ten participants had experiences with second sight in their families, but the examples discussed gave insight into how superstitions are practiced from beliefs. A superstition is a practice based on a belief that if x happens, y will be the result. In terms of second sight, someone has a psychic vision and with that information, they respond through superstition. In the case of Iona, she and her father shared a premonition dream and they believed that buying a particular object would later put Iona in danger. As a superstition, they did not purchase that item so Iona would be safe. The same happened with Andraste's mother, sensing something would go wrong, making her family leave, and five minutes later a plane crashed into their seats. Superstitions start with a belief, and are a form of agency (Goodall, 2010). More importantly, superstitious practices are important because they lead to a strong sense of identity with one's culture.

Identity significantly impacts how people define themselves within a community. Ancestry is one of the more common ways in which people identify themselves, as it offers a shared connection to other people with a shared history, resulting in a sense of camaraderie (Zerubavel, 2012). This is an example of cultural identity exhibited in the Nevada Scottish diaspora through the practice of traditional Celtic superstitions. Through practicing traditional superstitions and learning about the beliefs behind the superstitions in the case of the younger generation, members of the Nevada Scottish diaspora connect with their cultural identity. Members find camaraderie within the larger diaspora community through heritage groups such as the NSSC, but especially through practicing superstitions such as counting Corvids, knocking on wood, and for those within second sight families, acting upon premonitions. Identity in one's cultural community provides strength and self-awareness when one plays a larger role in a culture (Barrett, 2021). Participants reported pride and identity as key components of their Scottish heritage. Active engagement in one's cultural practices, such as through superstitions, is crucial to identity and the preservation of culture for future generations.

Acknowledgements

First, I would like to thank my participants for dedicating their time by sharing their experiences and stories for this research. I truly could not have accomplished this without each and every one of you. Secondly, I want to thank Dr. Erin Stiles for training, supervising, and mentoring me as I completed this project from start to finish. It was an honor learning from you for my first cultural ethnography. I would also like to thank the University of Nevada, Reno and its Anthropology department for nurturing my love of culture. Finally, I would like to thank my family for raising me with a passion for Celtic culture and practices, especially Grandpa John. You made me the researcher that I am today.

References

Barrett, Thomas. (2021, October). Walking in two worlds: connecting native youth with heritage, culture and identity. *Boys and Girls Club of America*. shorturl.at/dnBPS

Bueltmann, Tanja et al. (2013). The Scottish diaspora. *Edinburgh University Press.*

Caulfield, Jack. (2020, March). What is ethnography? Scribbr. https://www.scribbr.com/methodology/ethnography/

Cohn, Shari. (1999). Second sight and family history: pedigree and segregation analyses. University of Edinburgh. *Journal of Scientific Exploration*, *13*(3), 351-372. shorturl.at/exT29

Cwik, Mary et al. (2019). Let our Apache heritage and culture live on forever and teach the young ones. *American Journal of Community Psychology*, *64*(1-2), 137-145. shorturl.at/BDZ09

DePaul University. (2022). Defining diaspora. shorturl.at/gruGH

DeSilvey, Caitlin, & Rodney Harrison. (2020). Anticipating loss: rethinking endangerment in heritage futures. Informa UK. *International Journal of Heritage Studies*, *26*(1), 1-7. https://doi.org/10.1080/13527258.2019.1644530

Edensor, Tim. (2002). National identity, popular culture and everyday life. Oxford International Publishers.

Ergashev, Ibodulla, & Nodira Farxodjonova. (2021, January). Integration of national culture in the process of globalization. *Journal of Critical Reviews*, *7*(2). 477-479. https://doi:10.31838/jcr.07/02.90

Goodall, Janet. (2010). Superstition and human agency. University of Warwick. *Implicit Religion*, *13*(3), 307-318. https://doi:10.1558/imre.v13i3.307

Gunnyon, William. (1877). Illustrations of Scottish history, life, and superstitions from song and ballad. Hamilton, Adams, and Co.

Hvas Mortensen, Ditte. (2020). How to do a thematic analysis of user interviews. Interaction Design Foundation. https://www.interaction-design.org/literature/article/how-to-do-a-thematic-analysis-of-user-interviews

Jenkins, Richard. (2004). Spooks and spooks: black magic and bogeymen in Northern Ireland. Witchcraft Continued: Popular Magic in Modern Europe. Manchester University Press.

Livingstone, Sheila. (2021). Scottish customs. Birlinn Limited. The Estate of Sheila Livingstone.

McMahon, Mary. (2022, November). What does it mean to “knock on wood”? Language Humanities.org. shorturl.at/bBLS7

Napier, James. (1879). Folk lore or superstitious beliefs in the west of Scotland. Black Book Publications.

Newton, Michael. (2014). The Gaelic diaspora in North America.” The Modern Scottish Diaspora: Contemporary Debates and Perspectives. shorturl.at/mvWY1

Rahman Shakil, Shifur. (2019, January). Data collection methods: top-down vs. bottom-up. Taro Works. shorturl.at/bdDH4

Shersby, Megan. (2021, January). Corvids of the British Isles: how to identify, where to see them, and whether they are intelligent. Discover Wildlife. shorturl.at/akEZ7

Wright, Dudley. (1924). Druidism. The Open Court 1918, 11(4), 678-684. shorturl.at/hlKLU

Zerubavel, Eviatar. (2012, January). Ancestors and relatives: genealogy, identity, and community. Oxford University Press. shorturl.at/dyHN3

Zhang, Yan et al. (2013). Reversing one’s fortune by pushing away bad luck. American

Psychological Association. Journal of Experimental Psychology, 143(3), 1171-1184. https://doi:10.1037/a0034023

Investigating the Lived Experiences of Plurisexual Men of Color

Evan Tsuzaki, B.S. and Sarah N. Mitchell, Ph.D., CFLE
Department of Human Development, Family Science, and Counseling
University of Nevada, Reno

Abstract

It is well established that plurisexual individuals (those attracted to more than one gender), people of color, and men are underrepresented in LGBTQ+ research. Previous literature reveals distinct experiences for each of these identities under broader LGBTQ+ experiences, but there is yet to be a study that examines the intersection of all three identities. Through semi-structured interviews over Zoom with eight U.S. participants, this qualitative study explores the experiences and perspectives of those who identify as plurisexual men of color through three research aims: 1) examining attitudes and assumptions towards plurisexual identities, 2) assessing the intersection of interlocking sexual, racial and gender identities, and 3) understanding the perceived benefits of identities. Findings related to the three research questions indicate that nuanced challenges and rewards are experienced in the lives of plurisexual men of color. First, participants discussed experiencing pervasive invalidation of their plurisexual identities through a culture of dichotomous thinking. Next, racial and gender identities were understood as interlocking and merging, though some took precedence over others. Lastly, participants noted finding social support, empowerment, and a sense of individuality as positive aspects due to their identities. Findings underscore the importance of visibility and validation of plurisexual and racial minority experiences within LGBTQ+ research.

Keywords: plurisexual, person of color, intersectionality, men, lived experiences

Investigating the Lived Experiences of Plurisexual Men of Color

The future is queer: a 2021 Gallup poll found that 21% of adult Generation Z Americans, those born between 1997 and 2003, identify as part of the LGBTQ+ (lesbian, gay, bisexual, transgender, queer and other non-heterosexual or cisgender identities) community (Jones, 2022). Much of this growth was driven by an increased identification with bisexuality, with 66% of the Gen Z LGBTQ+ population identifying as neither gay/lesbian nor heterosexual (Jones, 2022). However, in a meta-analysis of 73 published sexuality texts within sociology and political science from 1970 to 2015, only 22% referenced bisexual individuals or bisexuality as frequently as lesbian or gay individuals/identities were referenced. Furthermore, 31% did not mention bisexuality at all despite including lesbian and gay references/content (Monro et al., 2017). It is worth noting that LGBTQ+ research was once termed “gay and lesbian studies,” by definition excluding other non-heterosexual identities until pivoting to “LGBTQ+ studies” in the 1990s (Richardson & Monro, 2012). Despite bisexual individuals now comprising a majority of the LGBTQ+ population, LGBTQ+ research still neglects bisexual experiences or subsumes bisexual individuals within lesbian and gay populations, not differentiating among those with unique experiences and identities (Barker et al., 2013). LGBTQ+ research must reflect the growing and evolving young

LGBTQ+ community, attending to the experiences of bisexual individuals.

The identity label “bisexuality” may not always accurately describe this growing population of people attracted to more than one gender. This study employs the term “plurisexuality,” an umbrella term that encompasses any sexuality that is attracted to more than one gender, including bisexual, pansexual, queer, etc. In contrast, “monosexuality” describes sexualities that are attracted to one gender, such as gay, lesbian, or straight identities (Galupo et al., 2015). For some, bisexuality, or “bi+,” has shifted its meaning past those attracted to the strict binary of women and men and includes gender-diverse people (Monro, 2015). However, this study is more interested in the broader experience of being attracted to more than one gender, regardless of the specific label one uses. “Plurisexual” encapsulates the aim to study those with plural attractions.

Plurisexuality: Research on Identity and Experiences

The low visibility of plurisexual individuals has led some scholars to describe plurisexuality as a “forgotten sexuality” (Kaestle & Ivory, 2012). Despite comprising more than half of the LGBTQ+ community, media representation of plurisexuality is not only minimal compared to lesbian and gay populations (Annenburg Inclusion Initiative, 2020), but the rare depictions of plurisexuality in media are often laden with harmful, stereotypical tropes (Gay and Lesbian Alliance Against Defamation, 2015). Contrary to the myth that plurisexual individuals navigate life easier than gay or lesbian populations due the potential to engage in heterosexual partnerships (Dodge et al., 2016), plurisexual individuals report elevated rates of depression, anxiety, suicidality, sexual violence, and substance use compared to gay and lesbian populations (Bauer et al., 2016; Ross et al., 2018; Salway et al., 2019; Taggart et al., 2019). Bauer and colleagues (2016) found that 19% of plurisexual individuals had three or more mental or substance use problems – more than any other group except transgender women.

Many LGBTQ+ scholars point to the stigma and discrimination towards plurisexual identities to explain this health disparity. Plurisexual individuals often face heterosexism and homophobia from outside of the LGBTQ+ community in addition to biphobia and monosexism from within the LGBTQ+ community (Ross et al., 2010). Some plurisexual individuals question their standing in LGBTQ+ spaces, often citing discrimination and erroneous assumptions about their plurisexual identity (Gonzalez et al., 2021). Dodge and colleagues (2016) revealed the most prevalent assumption regarding plurisexual individuals is that they are at heightened risk for HIV or other sexually transmitted infections. This view is thought to have originated from the HIV epidemic in the 1980s, when plurisexual individuals – men in particular, were stereotyped as a “bridge population” for HIV transmission between LGBTQ+ men to straight women (Jeffries, 2014). Other prominent stereotypes specific to plurisexual identities include not being a legitimate sexuality, being in denial about their sexuality, experimenting with their sexuality, being inherently more promiscuous, and being uninterested or incapable of maintaining long-term and monogamous relationships (Brewster & Moradi, 2010; Zivony & Lobel, 2014).

Considering Minoritized Racial/Ethnic Identity

The focus on people of color in this study is motivated by a dearth in research that considers race/ethnicity within plurisexual experiences. The umbrella term “people of color” is employed in this study to delineate those who are not White and share common experiences of having a minoritized racial/ethnic identity in the United States (Song, 2020). Historically, plurisexual studies have centered around

White individuals: Ghabrial and Ross (2018) found that in a representative sample of published studies on plurisexual identities from 1995 to 2016, only 15.7% of articles included a sample of at least 50% people of color and just 7% reported outcomes separately for people of color and White individuals. While looking at the progression of plurisexual research throughout time, the study found no significant progress over the past two decades (Ghabrial & Ross, 2018). Despite the underrepresentation of people of color in LGBTQ+ research, studies continually show distinct experiences compared to their White counterparts. LGBTQ+ people of color often report dissonance between their racial community and the LGBTQ+ community, causing one to feel they must "give up" one of their identities in order to feel accepted (Bowleg, 2013). Many LGBTQ+ people of color also feel the LGBTQ+ community as a whole is centered around White, affluent, cisgender, gay men, leaving those who do not fall within this narrow demographic feeling excluded and disconnected (Goltz, 2014; Nadal, 2013). The focus on those with minoritized racial/ethnic identities in this study is not to imply that White LGBTQ+ experiences are less important, but to address the lack of people of color in LGBTQ+ research and to assess the role of minoritized racial identities in shaping lived experiences.

Considering Male-Identified Experiences

In addition to plurisexual and minoritized racial identities, the third layer of this study investigates the influence of participants' gender identity as men. LGBTQ+ men face challenges distinct from LGBTQ+ women, considering that LGBTQ+ men report higher levels of stigma and discrimination and are more traditionally expected to conform to heteronormative gender roles than women (Dodge et al., 2016; Herek et al., 1997; Kite and Whitley, 1996). Perhaps this contributes to higher rates of plurisexual men engaging in "passing," or intentionally or unintentionally appearing as a member of the dominant (heterosexual) group compared to plurisexual women and other LGBTQ+ identities (Fuller et al., 2009). "Passing," often referred to as being on the "DL" (down-low), seems to both privilege and oppress plurisexual men: one study revealed that concealing one's plurisexual identity is correlated with higher income and protects against stigma and discrimination for being effeminate, but actually predicts worse mental health outcomes compared to those who do not conceal their sexual identity (Schrimshaw et al., 2013). Through an intersectional lens, the focus on men's experiences connects to Collins' (2000) notion of "penalty and privilege," which acknowledges that one can possess both socially privileged and disadvantaged identities. In this view, plurisexual men are socially privileged by their gender while being simultaneously disadvantaged by their intersection of race and sexual identity (Bowleg, 2013). This study examines how participants view their experiences at the crossroads of these advantaged and disadvantaged intersections.

Perceived Benefits of LGBTQ+ People of Color

Having discussed the extensive challenges plurisexual men of color may face, it is important to note not all intersectional research takes a deficit-based approach. Along with the adversity LGBTQ+ people of color face, research shows there are some perceived benefits this intersection offers. In Bowleg's (2012) qualitative study on the experiences of LGBTQ+ Black men, participants reported feeling liberated from traditional gender roles and expectations, experiencing psychological growth, and being open to new experiences. Further, health studies show that LGBTQ+ people of color have similar physical and mental health outcomes to White LGBTQ+ individuals (Balsam et al., 2015; Whitman & Nadal). This has led scholars to posit "positive intersectionality" when examining marginalized groups in which resilience, social support, and empowerment may buffer the challenges this population faces (Ghabrial et al., 2017). A strength-based approach may also illuminate mechanisms that may empower those with multiple marginalized identities.

Theoretical Frameworks

As a study directly inspired from tenants of intersectionality and minority stress theory, it is important to outline these frameworks. Coined by Kimberlé Crenshaw, intersectionality is a framework that examines the multiple identities one possesses, such as race, gender, class, sexuality, religion, etc., and how such identities intersect and interact with another to create systems of discrimination and privilege (Runyan, 2018). Identities are perceived not as additive but intersecting to create merging forms of discrimination and privilege (Crenshaw, 1989). Through a public health lens, minority stress theory posits that the stigma, prejudice, and discrimination that racial and sexual minorities face contribute to heightened mental health issues and psychological distress (Meyer, 2003). These frameworks guided the process of conceptualizing research aims, formulating questions, and analyzing key findings.

The Present Study

The experiences of plurisexual men of color are under-researched and overlooked. At the time of the present study, there is not published research that takes these three intersecting identities – plurisexuality, minoritized racial/ethnic identity, and being a man - into account through a qualitative study. Considering that extant research on each of these three identities reveals distinct experiences compared to broader LGBTQ+ experiences, bringing all three together creates a novel perspective of intersectionality within LGBTQ+ research. This study aimed to elucidate the gaps in the literature and address implications for professionals who may work with this population. Findings offer a sociocultural perspective on the lived experiences of plurisexual men of color, such that one may better understand lived realities of this population and become informed of ways to cultivate a less hostile environment for them. Three research questions were investigated:

1. What attitudes about plurisexuality are prevalent in the lived experiences of plurisexual men of color?
2. How do participants understand and describe the intersection of their identities as they pertain to their day-to-day experiences?
3. What, if any, perceived benefits do participants experience based on their race, gender, and sexual orientation identity?

Methods

This qualitative study was conducted to understand more about the lived experiences of plurisexual men of color. With the aim of describing the commonalities in day-to-day experiences (i.e., perceptions about plurisexuality, intersectional experiences, and positives) of a particular group, phenomenology was employed (see Creswell, 2013). This allowed for a deeper understanding of the experiences of being a plurisexual man of color as it pertained to the research questions. The research team also wanted to acknowledge their own positionality as researchers. Both investigators are members of the LGBTQ+ community and identify as Asian-American and Black, respectively. Though they may have some shared experiences with participants, they also understand that their experiences may be very different from those of their participants, especially considering their differences in singular identities. The research team frequently wrote memos and met to discuss their own experiences, challenges, and privileges while collecting and analyzing data. The investigators aspired to make no assumptions about what participants' responses would be regarding their experiences, allowing them to speak for themselves and describe their day-to-day experiences in relation to the main research questions. Their own words were utilized in constructing themes. No researcher is without bias, but in acknowledging and frequently reflecting on the researchers' own positionality, the study aimed to let the participants' words reveal the answer to the research questions.

Participants

Participants were eight plurisexual (e.g., bisexual, pansexual), cisgender or transgender men of color (any race that is not White) who were age 18 or older and residing in the United States. Participants were mostly young adults, with ages ranging from 18 to 30. Four participants identified as Black, two as Asian, one as mixed-race, and one as Chicano/Mexican. Due to utilizing a convenience sample in recruitment efforts, most participants were college educated, with five currently enrolled in college, two college graduates, and one forgoing college. Seven of the eight participants were cisgender men, and one was a transgender man. Five were currently single, two in a long-term relationship, and one married (see Table 1 for sample description). Participants hailed from seven U.S. states across the Western, Mountain, Midwest, and East Coast regions in both rural and urban areas. All participants had access to a computer and Wi-Fi to participate in the study.

Procedure

Before research commenced, an Institutional Review Board (IRB) approved this study on July 19, 2020. From summer of 2020 to spring of 2022, an online survey administered using Qualtrics software was posted on the Social Psychology SONA platform for a large public university in the western United States. The SONA platform incentivizes students to participate in studies to gain SONA "credits" which could count towards requirements or extra credit for academic courses. The students who participate in SONA research are required to be 18 and older and are usually students enrolled in social sciences courses. Recruitment efforts were augmented through online recruitment posts to two online discussion forums, Craigslist and Reddit. On Craigslist, recruitment posts were posted to 12 large cities in the United States. On Reddit, posts were targeted to LGBTQ+-related subreddits as well as college or university subreddits. Posts were only made on subreddits, or discussion forums within Reddit, that allowed research advertisements. For subreddits that required IRB verification or moderator approval, such approval was sought before posting.

All advertisements indicated that the research team was interested in interviewing anyone who was attracted to more than gender, identified as a man of color, was age 18 or older, and residing in the United States. A link to the Qualtrics survey was included, which contained demographic questions, quantitative questions about experiences, and a place to leave contact information if they chose to do so. Advertisements also indicated that if chosen to be interviewed, participants would receive a $10 gift code to Amazon.com for each interview (up to three). If survey participants met the targeted demographic, left an email and/or phone number, and indicated interest in being interviewed, the primary investigator invited them to a Zoom interview via email or via text (utilizing email to text technology). All potential participants were informed that the study was completely anonymous and one could back out of the interview at any time or decline to answer any question. Interviews were scheduled based on participant and primary investigator availability.

All interviews were conducted via Zoom and lasted from thirty minutes to one hour. Participants were asked to read a consent form via the shared screen feature, and after consenting to be interviewed, were asked to come up with their own pseudonym before the audio-only recording started. The interviews followed a semi-structured script with 40 open-ended questions and opportunities for the primary investigator to ask clarifying questions. The 40 scripted questions plus any clarifying questions were worded with the purpose of better understanding their lived experiences as it pertained to the three main research questions. Of the eight participants, two completed two interviews, and six completed one interview. Upon completion of an interview, participants were emailed a $10 Amazon gift code as remuneration for their participation. The primary investigator wrote memos after each interview to reflect on the discussion and how it went, including their own positionality, participant mood, and main ideas brought up by the participant. Transcriptions of the interviews were produced via Otter software, then manually checked and corrected by the primary investigator. Transcripts were then uploaded to Dedoose, a qualitative data analysis software.

Analysis

In Dedoose, the primary investigator coded transcriptions utilizing inductive thematic analysis. Kiger and Varpio (2010) outline thematic analysis as a method to derive themes, or patterned responses or meanings, across a qualitative data set to answer a research question. An inductive approach, as opposed to deductive, allows themes to be described and interpreted from the data without a pre-existing theory or framework (Braun & Clarke, 2006). Themes do not emerge based on the frequency of appearance in the data but are actively identified and constructed to provide insights to the study's research questions (Kiger & Varpio, 2010). The primary investigator suggested the initial themes and met with the secondary investigator to review, refine, and finalize the findings. Upon the completion of interviews, the primary investigator conducted a member check interview with one of the participants. The participant was presented with the initial findings and discussed their thoughts on the content and wording of key points. The member check interview is a process intended to reduce researcher bias and increase the credibility of a qualitative study (Birt et al., 2016). The member check participant agreed with a majority of the themes and suggested some minor changes which were integrated into the final findings. For example, the participant cautioned against using language to generalize the experiences of all plurisexual men of color, noting the diversity of experiences among specific racial/ethnic groups.

Findings and Discussion

In wanting to better understand the lived experiences of plurisexual men of color, research questions probed for attitudes towards plurisexuality, how intersecting identities were understood, and perceptions of benefits around identities. Each research question resulted in themes outlined below in three sections (see Table 2). A discussion of the results, including implications, follows each of the three sections.

Research Question 1: Attitudes Towards Plurisexuality

As discussed previously, there are numerous stereotypes and assumptions directed toward plurisexual identities. The purpose of the first research question was to gauge whether participants experienced such stereotypes firsthand and how they conceptualized the influence of such attitudes on their lived experiences. Three themes resulted from participant interviews. The most prevalent and impactful assumption about plurisexuality could be summed up in one word: invalidation.

Participants described plurisexual invalidation in two ways, 1) feeling pressure to "pick a side" and 2) the idea that one's true sexuality is determined by the gender of their current or past partners. Additionally, some participants confirmed that they 3) experienced the stereotype that plurisexual individuals are more promiscuous, non-committal, and less family oriented.

Feeling Pressure to "Pick a Side"

An overarching experience for nearly all participants was experiencing a pressure to "pick a side" between gay and heterosexual orientations. Participants would often use the phrase "choose a side" or "pick a side" to describe how others felt about their sexuality. As John (18, Asian/Japanese) summarized, "People think it's stupid because why can't you just choose one? It [my sexual orientation] doesn't really exist." This often insinuated an invalidating message towards plurisexual identities, especially when coming from others in the LGBTQ+ community. George (20, Asian/Filipino) explained,

> Some people are super like, "You need to pick a side. You need to be either gay or straight." Which does really suck when you hear the latter from someone who's in the LGBT community. It's like, why are you forcing people to choose sides when it's already hard enough to say that I am in this community?

Participants clarified that not everyone in LGBTQ+ community held this view or had varying degrees of bias towards plurisexual identities. Nonetheless, most participants felt some degree of stigma against plurisexual identities from within the LGTBQ+ community, either through memorable firsthand experiences or through observation. Being the most common expression brought up by participants in the study, the notion that one should "pick a side" exemplifies a prevalent and invalidating attitude towards plurisexual identities.

One's Partner Determining "True" Sexuality

For participants in a relationship, the attitude that they were either truly gay or heterosexual was heightened. Participants explained how the gender of their partner seemed to confirm to others their "true" sexuality. JJ (21, Black) said,

> [It's viewed as] whoever your current partner is, that's like what you really are. So if you're a boy and you're with a girl, then you're actually straight. And if you're a boy and you're with a boy, then you're actually gay.

Other participants echoed experiences of witnessing plurisexual identities being erased based on who someone was partnered with. George (20, Asian/Filipino) described his experience:

> In my experience of becoming friends with other bi guys, some of them feel like they don't really fit into LGBT spaces, especially if they're in a "heterosexual" relationship. Because it's like, I don't feel like I'm supposed to be in this space right now. Because I'm dating a girl or something like that. And that's just really dumb. Like, you're still bisexual.

Participants' experiences in this study suggest that one's relationship status enforced the notion that plurisexual individuals could only be heterosexual or gay. In addition, for some participants the gender of their partner either bolstered or weakened their sense of belonging in the LGBTQ+ community.

Plurisexual Individuals as More Promiscuous and Less Committal

Past research has highlighted how plurisexual individuals are sometimes viewed as inherently more promiscuous and less committal than monosexual people (Zivony & Lobel, 2014). In the sample of this research, all but one participant seemed to relate to being stereotyped as such. Six participants mentioned being perceived at greater risk for STIs by family members, friends, partners, or healthcare providers. Some noted that this assumption could be attributed to being MLM (men loving men) rather than due to their plurisexuality.

Five participants experienced the automatic assumption that plurisexual individuals were less interested in committed, monogamous, and family-oriented relationships. Vance (30, Black) recounted "when I told my mom [about my bisexuality], she just kind of assumed that there would be no kids in the picture." Assumptions about relationships were also common, as Ben (25, Black/White) explained,

> I've definitely gotten comments from an acquaintance before that asked me if my relationship was open, and I'm like "No," and they're like, "Wait, but you're bi so it's not open?" I'm like, "No! How many bi people do you know with open relationships?" And they were like "None." I was like, "Okay…"

Other participants would often explain how others equated plural attractions to open, polyamorous, and less stable relationships. Overall, myths and assumptions around heightened promiscuity seemed to be prevalent for most participants in this study.

Discussion and Implications of Research Question 1

Findings illustrate that plurisexual individuals are met with a number of attitudes that revolve around invalidation, misunderstanding, and skepticism. Plurisexual identities are often invalidated through dichotomous thinking and categorization, the idea that one could only be "either/or" heterosexual or gay, with no regard that sexualities with plural attractions could exist. The dichotomy of sexuality has been discussed by Bradford (2004) who asserts that plurisexual individuals must question and challenge a dominant culture that upholds dichotomous views of sexuality. From the experiences of the participants, this challenge seemed to be quite stressful in their day-to-day experiences; not only do they belong to a minoritized sexual orientation but must navigate a culture that sees their sexualities as not real and would prefer them to "pick" heterosexual or gay identities. Experiencing these messages from within the LGBTQ+ community carried an alienating message and insinuated a precarious place in the LGBTQ+ community. In addition, their plurisexual identity brought the assumption that their relationships were automatically non-monogamous or less family oriented – something that participants felt was hardly the case.

An apparent implication is that plurisexual identities should be validated as real sexualities. Education and representation of plurisexual identities is paramount, especially to those within the LGBTQ+ community. LGBTQ+ spaces should celebrate plurisexual individuals as firmly part of the community, not dependent on the gender of their partner. Separate from a mere acceptance of minoritized sexualities, understanding and celebrating the continuum of plurisexual sexualities might help to dismantle dichotomous views of sexuality. Those who work with LGBTQ+

populations stand to benefit by understanding how invalidation and alienation due to dichotomous thinking harms plurisexual individuals. Assuming that plurisexual individuals are automatically at higher risk of STIs may be a sensitive and bothersome assumption for some, impacting how others, including potential partners, treat them.

Research Question 2: Balancing Intersecting Identities

As a study that is directly inspired by intersectional frameworks, the second focus of study was to explore the interlocking relationships among being plurisexual, a person of color, and a man. Rather than comparing the struggles and experiences of each intersection, this aim investigated how each identity influenced or related to other identities. This resulted in three themes around the 1) primacy of racial and transgender identities, the experience that 2) racial identities bolstered ideals of masculinity, and the perceptions of 3) gender differences in plurisexual experiences.

Primacy of Racial and Transgender Identities

In response to questions that asked about how participants' race, sexuality, and gender interacted with each other, participants voiced similar answers: that although all their identities were important in different ways, their racial or transgender identity was most salient in their lives. A common response was that one could "tone down" or code-switch their plurisexual identity if they wanted to, but that race was something others can always perceive. As Sebastian (21, Chicano/Mexican) stated, "I can hide being bisexual. I can easily hide it. I can't hide my skin color. I can't hide my culture." At the same time, many participants expressed an enmeshed view of their identities in that it was difficult to independently assess one of their identities without considering the influence of other identities. George (20, Asian/Filipino) described this,

> I don't know, just leaving off one of the two feels like I'm not describing my whole self if that makes sense. But obviously, sometimes I do feel like I have to leave off my sexuality. But if I had to pick one or the other as far as which is more important to me, I would say that the fact that I'm Filipino is more important to me.

While this line of questioning was not meant to compare identities, ultimately, seven of the eight participants voiced that racial identities remained more important to their lives. Other than race, JJ (21, Black), who is a transgender man, explained that his transgender identity was more salient to him than his plurisexual identity: "I'm trans before I'm bisexual because people want to see your gender expression before, in my experience." Many participants viewed their identities as interconnected, but many also conveyed the reality that some identities were more influential in their lives than others.

Racial Identities Bolstering Ideals of Masculinity

Some questions probed how participants viewed the interplay of their sexuality and racial identities. Many participants discussed how their racial community upheld more stringent standards of masculinity. Kerry (20, Black/White) explained,

> I would say that being an African American man that's not straight is generally looked down upon in the Black community, especially because there's this idea of Black men being super masculine, almost hyper masculinized. So, I tend to be a little bit more reserved about it when it comes to talking to groups that are predominantly Black just

> because there's this stigma against LGBT people.

Six participants agreed that there was some extent of discord between the LGBTQ+ community and their racial community. Compared to White individuals, many expressed the view that their culture defined their gender roles as men. Sebastian (21, Chicano/Mexican) discussed masculinity in his culture:

> Growing up in Hispanic household there's kind of a stricter ideal for being a man in that type of culture, specifically something called machismo, which is something that's kind of ensuring if you're a man… you have those qualifications: those characteristics of what it is to be a man, whether it be strong, having a mustache, having a deep voice, going into construction, playing soccer or any other sport – something along those lines.

For many participants, presenting as more masculine in their racial communities produced rewards such as appeasing family members, gaining acceptance from peers, and avoiding potential discrimination. Some pointed to code-switching as a mechanism for balancing these multiple and often conflicting identities in a way that allowed them to navigate varying environments more easily. Sebastian (21, Chicano/Mexican) described code-switching as toning down parts of his personality in certain contexts since "having a lower pitched voice, how you dress, how you walk, kind of determines if you're a man or not." Other participants noted changes in whether they cross their legs while sitting or deliberately avoiding the subject of their sexuality in conversation with others. While these behaviors seemed to act as a protective measure, some acknowledged their own assumptions about their racial community. As Kerry (20, Black/White) noted,

> I feel I do try to hide my identity from people who are Black and specifically Black men. Just because I have this idea in my head that they aren't going to be accepting of it. So, I feel like I have my own biases there as well.

Gender Differences in Plurisexual Experiences

The last focus of this research question tasked participants to think about their experiences as plurisexual men compared to plurisexual women. Though plurisexual women of color might relate to many of the other themes discussed in this study, there were some perceived differences in experiences due to gender. The most overarching belief was that plurisexual women are generally more accepted in society than men. George (20, Asian/Filipino) mentioned "If you ask a straight guy his opinion on a bi girl, he might be more accepting of it than a bi guy because bi women are very attractive to straight guys." The latter half of George's quote connects to another prominent view: that though participants felt plurisexual women are more accepted, they are often hypersexualized and sexually objectified. No participants in this study felt they were hypersexualized as men due to their plurisexual identity, but almost all speculated that plurisexual women were. Some participants also recognized their privileged gender identity as men, noting that being a woman in their respective culture was often more difficult due to expectations to act a certain way.

Discussion and Implications of Research Question 2

An intersectional view establishes that identities are not additive but merging and interconnected with each other. Despite this intention to discuss identities in this view, it was evident that participants described racial and transgender identities as more salient compared to plurisexual identities. This does not negate the value of an intersectional lens but instead suggests that not all identities influence one's lived experiences to the same degree. Perhaps at times a singular, visible identity takes precedence over invisible, concealable identities. Participants felt their plurisexual identity, unlike their racial or transgender identities, is often visible and unconcealable to others. Additionally, one's race is not limited to skin color or experiences of racial discrimination but ties together with culture, family, history, language, traditions, etc. Perhaps the expansive influence of one's racial identity explains why race was more central to many participants' lives.

Despite the primacy of race, tasking participants to discuss their identities through an intersectional lens resulted in conversations related to Collins's (2000) notion of penalty and privilege. Participants recognized their privilege as men but noted their racial and gender identities influencing this privilege. Often their racial/ethnic communities upheld strict standards of masculinity which conflicted with their plurisexual identity. Many participants also observed a greater societal acceptance of plurisexual women compared to men. Their responses illustrate that participants understood each identity as merging with other identities to create a unique set of experiences, rather than simply adding and subtracting privileged and disadvantaged identities. Participants did not feel that being plurisexual and a racial minority counteracted or erased their privilege, but qualitatively altered the way that they perceived and experienced their privilege as men. Others' observations of these men, as well as their own assumptions about how others would see them, points to the intersecting nature of race/ethnicity, gender, sexuality, culture, and the expectations for behavior based on these identities. This study confirms that an intersectional lens is paramount in any research discussing social identities. Researchers stand to benefit from studying and implementing intersectional frameworks in future LGBTQ+ studies.

Research Question 3: Perceived Benefits of Identities

With the first two research questions focusing on challenging aspects, the third research question explored any positive aspects or rewards that resulted from such identities. Acknowledging the positive aspects of the participants' identities is not to dismiss any challenges but is meant to highlight the reality that intersectional experiences are not solely about deficits. Thus, the interview script included direct questions about the perceived benefits of being a plurisexual man of color (e.g., What, if any, positives in your life come out of having the identities that you have?). Two types of responses resulted from these discussions: 1) finding social support and community through identities and 2) gaining a sense of individuality and empowerment due to identities.

Social Support and Community

All eight participants mentioned that their identities enabled them to locate and foster meaningful relationships with others. Other individuals with LGBTQ+ identities would often become a source of social support and were described as one's "community" or "family." Nick (26, Black) said, "The best parts come when I'm associating with the LGBTQ family because they are the ones who can understand my orientation." Types of social support included friendships, romantic relationships, friend groups, and support groups. Social supports were central aspects of participants' lives, acting to validate their experiences especially as they were realizing and developing their sexuality identity. Some participants mentioned friends encouraging and guiding them to come out and embrace their plurisexual identity. For many participants, friendships were found both in real-life and via digital, online contexts.

Participants often credited their identities in allowing them to open up to new friends and friend groups. Being LGBTQ+ seemed particularly helpful when befriending women as Vance (30, Black) explained,

> I remember when I told a couple friends who are women, Black women, they seemed to change a little bit in that they were more open with talking about guys in front of me. And just I don't know, there's like a different energy that wasn't there when they thought I was straight.

In particular, some participants felt their plurisexual identity allowed for certain connections that might not exist if they were straight. Such connections, especially with women, enabled some to become more open or vulnerable with their emotions. Ben (25, Black/White) gave his thoughts on this:

> Guys like, especially straight guys, talk about their feelings less, so I feel like it's easier [being bisexual]. I have noticed how even like the friends I have, like the girlfriends I have, they're a lot easier to talk with about emotions.

Compared to straight men, participants in this study felt that their sexuality drew them closer to friendship circles with more LGBTQ+ individuals and women. Participants seemed to perceive these relationships to be more meaningful and emotionally supportive compared to relationships with straight men. Additionally, being a member of a minoritized racial group influenced participants' types of friend groups as well. Ben explained, "My main friend group – it's all people of color. So, I quite literally would not know some of my best friends if I was not a person of color."

Individuality and Empowerment

Participants recognized their identities of being plurisexual, a person of color, and a man as unique, and for many, a source of individuality and empowerment. Being part of different communities was something to be proud of, as Vance (30, Black) explained, "There's a lot of talent and energy and passionate people in that community. And it's showing in different areas of life, whether through art, or in the most random places." For many, these identities defined who they were as a person and opened them up to new perspectives. Sebastian (21, Chicano/Mexican) explained,

> Pride, happiness, kind of an acceptance, you know, it defines me, it makes me unique, I have something to kind of show off…And in terms of being Mexican, that's my entire life right there – I think it's something I'm very prideful about, that's for sure.

These intersecting identities, more so their plurisexual and racial identities as opposed to being a man, comprised central aspects of participants' lives. Many felt that learning to navigate life with such identities shaped them to be stronger and more resilient to challenging situations. Kerry (20, Black) explained this:

> I feel like it's also made me someone who's a lot more resilient and proud of who I am as a person just because I do have to go through these struggles of not feeling accepted. Because these three factors are not things that I can really change. So, I'm just gonna take it as just be proud of having those identities.

Participants did not view themselves as mere victims to the struggles that come with having the identities they had. Though the challenges are notable, having to deal with such hardships seemed to be a source of resilience and empowerment. They could not change the identities they were born with, so they learned to accept and embrace who they are. Of note, some participants made it clear that these identities only partially described them; they were multi-faceted individuals that had more to offer than just these labels in their experiences of challenges, empowerment, and life in general.

Discussion and Implications of Research Question 3

Focusing solely on the challenges of identity membership leaves out any positive aspects of participants' lived experiences. This research question also elucidates what one can do for individuals to empower them to be their own champions. Clearly, that capacity is there for this population. Plurisexual men of color considered their multiple identities intersectional rather than additive; they were an individual first and foremost rather than a summation of their multiple identities. The intersection of identities could be both a source of hardship and empowerment at the same time. Denying one aspect gives only a partial picture of their stories. Furthermore, social support is crucial for plurisexual men of color in this sample, who valued their relationships in numerous ways. Those who work with this population may help by encouraging friendships and fostering spaces for those with marginalized identities. Community, both online and in real life, could be utilized as a source of comfort, education, encouragement, honesty, and validation. Additionally, practitioners who share similar identities and experiences may be able to better relate to their experiences and support them. Future research should continue to investigate any positives in intersecting identities to understand the full breadth of experiences.

Limitations and Conclusions

As a younger, more diverse generation joins an expanding LGBTQ+ community, there is need for research to highlight the plethora of experiences under the LGBTQ+ umbrella. This qualitative study focused on the intersection of three demographics that are traditionally underrepresented in research: plurisexual identities, minoritized racial identities, and men. Guided by an intersectional framework, this study sought to better understand the experiences of the participants through three research questions: 1) What attitudes about plurisexual identities are prevalent in the lived experiences of this sample, 2) How do participants understand and describe the intersection of their identities, and 3) What, if any, perceived benefits do participants experience on the basis of their race, gender, and sexual identity?

Due to the design of this study, there are limitations to consider. As a qualitative study with a small sample size, these findings are not generalizable to all plurisexual men of color. Participants in this study volunteered themselves through collegiate research and online platforms, resulting in a younger, highly educated sample. It is also established that volunteers in research tend to be more extroverted, agreeable, and open to experiences than the general population (Rosenthal & Rosnow, 1975). Participants in this study were open to sharing personal details about their lives and were comfortable talking about their plurisexual identity with a researcher. This study does not capture the experiences of those who may be figuring out, questioning, concealing, or simply not comfortable with sharing their experiences. Regarding minoritized racial identities, this study aimed to recruit a diverse sample of people of color. However, this study was not able to recruit/include those with Native American, Pacific Islander, Middle Eastern or other minoritized racial/ethnic backgrounds. The research team also acknowledges the diversity of experiences within the catch-all term “people of color” and that socioeconomic status, religion, education, environment, family, culture, etc. are salient factors that were not considered as extensively in this study. Additionally, while the research team sought to increase the study’s validity and reliability by considering reflexivity, working together to discuss their own positionality and the research findings, and completing a member check interview, there is always some degree of researcher bias. This is acknowledged not to discredit the results or qualitative work in general, but to highlight the contributions that honesty and critical reflexivity brings to the rigor of qualitative work.

Despite these limitations, the study was able to gather insights and discern themes addressing the three research questions. Attitudes towards plurisexual identities are often invalidating and based in a dichotomous view of sexuality. Other common experiences include feelings of alienation from the LGBTQ+ community and experiencing stereotypes that plurisexual identities equate to increased promiscuity. Though perceptions around identities were largely intersectional, many participants felt their racial or transgender identities took precedence over their plurisexual identity. Racial identities were often perceived as conflicting with sexual identities, with code-switching being a common mechanism for navigating between varying communities. Participants often felt plurisexual men were generally not as accepted as women while also recognizing the hyper sexualization of plurisexual women and their position of privilege as men. Along with these challenges there were notable benefits to this intersection, with social support and community being a key part of fostering resilience. Many also felt empowered in their individuality through their multiple marginalized identities.

Through sharing stories and experiences, highlighting challenges and strengths, and offering perspectives on merging identities, the participants’ words enhance the current literature on intersectional LGBTQ+ research. The findings of this study are valuable for researchers, practitioners, and individuals as a whole in their relations and day-to-day interactions with plurisexual men of color. As the LGBTQ+ population continues to expand in both number and diversity, there is an exciting need for future research to explore the dynamics of partnerships for plurisexual individuals, alienation due to identity membership in LGBTQ+ spaces, and culture-specific values in relation to LGBTQ+ identities.

Acknowledgements

First, we would like to thank the participants for their vulnerability in sharing their lived experiences with us. Their stories allowed us to learn more about intersectional experiences within the LGBTQ+ community and we are grateful for their contributions to family science. We would also like to acknowledge and thank the Office for Undergraduate Research for partially funding this project. This study would not be possible without their financial support and unwavering encouragement.

References

Annenburg Inclusion Initiative. (2020, September). Inequality in 1,300 popular films: Examining portrayals of gender, race/ethnicity, LGBTQ & Disability from 2007 to 2019. https://assets.uscannenberg.org/docs/aii-inequality_1300_popular_films_09-08-2020.pdf

Balsam, K. F., Molina, Y., Blayney, J. A., Dillworth, T., Zimmerman, L., & Kaysen, D. (2015). Racial/ethnic differences in identity and mental health outcomes among young sexual minority women. Cultural diversity & ethnic minority psychology, 21(3), 380–390. https://doi.org/10.1037/a0038680

Barker, M., Richards, C., Jones, R., Bowes-Catton, H., Plowman, T., Yockney, J., & Morgan, M. (2012). The bisexuality report: Bisexual inclusion in LGBT equality and diversity. Centre for Citizenship, Identity and Governance, The Open University. http://oro.open.ac.uk/52881/1/The%20BisexualityReport%20Feb.2012_0.pdf

Bauer, G. R., Flanders, C., MacLeod, M. A., & Ross, L. E. (2016). Occurrence of multiple mental health or substance use outcomes among bisexuals: A respondent-driven sampling study. BMC Public Health, 16(1), 1–11.

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? Qualitative Health Research, 26(13), 1802–1811. https://doi.org/10.1177/1049732316654870

Bowleg, L. (2013). "Once you've blended the cake, you can't take the parts back to the main ingredients": Black gay and bisexual men's descriptions and experiences of intersectionality. Sex Roles: A Journal of Research, 68(11-12), 754–767. https://doi.org/10.1007/s11199-012-0152-4

Bradford, M. (2004). The Bisexual Experience: Living in a Dichotomous Culture. Journal of Bisexuality, 4(1-2), 7–23. https://doi.org/10.1300/J159v04n01_02

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brewster, M. E., & Moradi, B. (2010). Perceived experiences of anti-bisexual prejudice: Instrument development and evaluation. Journal of Counseling Psychology, 57(4), 451–468. https://doi.org/10.1037/a0021116

Collins, P. H. (2000). Black feminist thought: Knowledge, consciousness, and the politics of empowerment (2nd ed.). Routledge. https://doi.org/10.4324/9780203900055

Crenshaw, K. W. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory, and antiracist politics. University of Chicago Legal Forum, 1989(1), 139–167.

Creswell, J. W. (2013). Qualitative inquiry and research design: Choosing among five approaches (3rd ed.). Sage.

Diamond, L. (2016). Sexual fluidity in males and females. Current Sexual Health Reports, 8, 249–256. https://doi.org/10.1007/s11930-016-0092-z

Dodge, B., Herbenick, D., Friedman, M. R., Schick, V., Fu, T. J., Bostwick, W., Bartelt, E., Muñoz-Laboy, M., Pletta, D., Reece, M., & Sandfort, T. G. (2016). Attitudes toward bisexual men and women among a nationally representative probability sample of adults in the United States. PloS One, 11(10), 1–18. https://doi.org/10.1371/journal.pone.0164430

Fuller, C. B., Chang, D. F., & Rubin, L. R. (2009). Sliding under the radar: Passing and power among sexual minorities. Journal of LGBT Issues in Counseling, 3(2), 128–151. https://doi.org/10.1080/15538600903005334

Friedman, M.R., Bukowski, L., Eaton, L.A., Matthews, D.D., Dyer, T.V., Siconolfi, D., & Stall, R. (2019). Psychosocial health disparities among Black bisexual men in the U.S.: Effects of sexuality nondisclosure and gay community support. Archives of Sex Behavior, 48(1), 213–224. https://doi.org/10.1007/s10508-018-1162-2

Friedman, M. R., Dodge, B., Schick, V., Herbenick, D., Hubach, R., Bowling, J., Goncalves, G., Krier, S., & Reece, M. (2014). From bias to bisexual health disparities: Attitudes towards bisexual men and women in the United States. LGBT Health, 1(4), 309–318. https://doi.org/10.1089/lgbt.2014.0005

Galupo, M. P., Mitchell, R. C., & Davis, K. S. (2015). Sexual minority self-identification: Multiple identities and complexity. Psychology of Sexual Orientation and Gender Diversity, 2(4), 355–364. https://doi.org/10.1037/sgd0000131

Gay and Lesbian Alliance Against Defamation (GLAAD). (2022). Where we are on TV report – 2021-22. https://www.glaad.org/sites/default/files/GLAAD%20202122%20WWATV.pdf

Ghabrial, M. A. (2017). "Trying to figure out where we belong": Narratives of racialized sexual minorities on community, identity, discrimination, and health. Sexuality Research & Social Policy, 14(1), 42–55. https://doi.org/10.1007/s13178-016-0229-x

Ghabrial, M.A. & Ross, L.E. (2018). Representation and erasure of bisexual people of color: A content analysis of quantitative bisexual mental health research. Psychology of Sexual Orientation and Gender Diversity, 5(2), 132–142. http://dx.doi.org/10.1037/sgd0000286

Goltz, D. B. (2014). "We're not in Oz anymore": Shifting generational perspectives and tensions of gay community, identity, and future. Journal of Homosexuality, 61(11), 1503–1528. https://doi.org/10.1080/00918369.2014.944042

Gonzalez, K.A., Flanders, C. E., Pulice-Farrow, L., & Bartnik A. (2021). "It's almost like bis, pans kind of stick together:" Bi + belonging and community connection. Journal of Bisexuality, 21(2), 194–224. https://www.tandfonline.com/doi/full/10.1080/15299716.2021.1927282

Herek, G. M., Gillis, J. R., Cogan, J. C., & Glunt, E. K. (1997). Hate crime victimization among lesbian, gay, and bisexual adults: Prevalence, psychological correlates, and methodological issues. Journal of Interpersonal Violence, 12(2), 195–215. https://doi.org/10.1177/088626097012002003

Hudson, K. D., & Romanelli, M. (2020). "We are powerful people": Health-promoting strengths of LGBTQ communities of color. Qualitative Health Research, 30(8), 1156–1170. https://doi.org/10.1177/1049732319837572

Jackson, C.L., Agénor, M., Johnson, D.A., Austin, S.B., & Kawachi, I. (2016). Sexual orientation identity disparities in health behaviors, outcomes, and services use among men and women in the United States: A cross-sectional study. BMC Public Health, 16(1), 1–11. https://doi.org/10.1186/s12889-016-3467-1

Jeffries W. L., 4th (2014). Beyond the bisexual bridge: sexual health among U.S. men who have sex with men and women. American Journal of Preventive Medicine, 47(3), 320–329. https://doi.org/10.1016/j.amepre.2014.05.002

Jones, J. (2022, February 17). LGBT Identification in U.S. Ticks up 7.1%. Gallup Inc. https://news.gallup.com/poll/389792/lgbt-identification-ticks-up.aspx

Kaestle, C. E., & Ivory, A. H. (2012). A forgotten sexuality: Content analysis of bisexuality in the medical literature over two decades. Journal of Bisexuality, 12(1), 35–48. https://doi.org/10.1080/15299716.2012.645701

Kiger, M. E., & Varpio, L. (2020): Thematic analysis of qualitative data: AMEE Guide No. 131. Medical Teacher, 42(8), 846–854. https://doi.org/10.1080/0142159X.2020.1755030

Kite, M. E., & Whitley, B. E. (1996). Sex differences in attitudes toward homosexual persons, behaviors, and civil rights: A meta-analysis. Personality and Social Psychology Bulletin, 22(4), 336–353. https://doi.org/10.1177/0146167296224002

Meyer I. H. (2003). Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. Psychological bulletin, 129(5), 674–697. https://doi.org/10.1037/0033-2909.129.5.674

Monro, S. (2015). Bisexuality: Identities, politics and theories. Basingstoke, UK: Palgrave Macmillan.

Monro, S., Hines, S., & Osborne, A. (2017). Is bisexuality invisible? A review of sexualities scholarship 1970–2015. The Sociological Review, 65(4), 663–681. http://dx.doi.org/10.1177/0038026117695488

Nadal, K. L. (2013). That's so gay! Microaggressions and the lesbian, gay, bisexual, and transgender community. American Psychological Association. https://doi.org/10.1037/14093-000

Paul, R., Smith, N. G., Mohr, J. J., & Ross, L. E. (2014). Measuring dimensions of bisexual identity: Initial development of the Bisexual Identity Inventory. Psychology of Sexual Orientation and Gender Diversity, 1(4), 452–460. https://doi.org/10.1037/sgd0000069

Richardson, D., & Monro. S. (2012) Sexuality, Equality and Diversity. Palgrave Macmillan.

Rosenthal, R., & Rosnow, R. L. (1975). The volunteer subject. John Wiley & Sons.

Ross, L. E., Dobinson, C., & Eady, A. (2010). Perceived determinants of mental health for bisexual people: a qualitative examination. American Journal of Public Health, 100(3), 496–502. https://doi.org/10.2105/AJPH.2008.156307

Ross, L. E., Salway, T., Tarasoff, L. A., MacKay, J. M., Hawkins, B. W., & Fehr, C. P. (2018). Prevalence of depression and anxiety among bisexual people compared to gay, lesbian, and heterosexual individuals: A systematic review and meta-analysis. Journal of Sex Research, 55(4-5), 435–456. https://doi.org/10.1080/00224499.2017.1387755

Runyan, A. (2018, November). What is intersectionality and why is it important? American Association of University Professors. https://www.aaup.org/article/what-intersectionality-and-why-it-important#.YmJHx_PML-Y

Salway, T., Ross, L. E., Fehr, C. P., Burley, J., Asadi, S., Hawkins, B., & Tarasoff, L. A. (2019). A systematic review and meta-analysis of disparities in the prevalence of suicide ideation and attempt among bisexual populations. Archives of Sexual Behavior, 48(1), 89–111. https://doi.org/10.1007/s10508-018-1150-6

Schrimshaw, E. W., Siegel, K., Downing, M. J., & Parsons, J. T. (2013). Disclosure and concealment of sexual orientation and the mental health of non-gay-identified, behaviorally bisexual men. Journal of Consulting and Clinical Psychology, 81(1), 141–153. https://doi.org/10.1037/a0031272

Song, M. (2020). Rethinking minority status and 'visibility.' Comparative Migration Studies, 8(5), 1–17. https://doi.org/10.1186/s40878-019-0162-2

Taggart, T. C., Rodriguez-Seijas, C., Dyar, C., Elliott, J. C., Thompson, R. G., Jr, Hasin, D. S., & Eaton, N. R. (2019). Sexual orientation and sex-related substance use: The unexplored role of bisexuality. Behaviour Research and Therapy, 115, 55–63. https://doi.org/10.1016/j.brat.2018.12.012

Tangela S. R., Sharon G. H., & William T. H. (2015). Between a gay and a straight place: Bisexual individuals' experiences with monosexism. Journal of Bisexuality, 15(4), 554–569. https://www.tandfonline.com/doi/full/10.1080/15299716.2015.1111183

Whitman, C. N., & Nadal, K. L. (2015). Sexual minority identities: outness and well-being among lesbian, gay, and bisexual adults. Journal of Gay & Lesbian Mental Health, 19(4), 370–396. https://doi.org/10.1080/19359705.2015.1038974

Zivony, A., & Lobel, T. (2014). The invisible stereotypes of bisexual men. Archives of Sexual Behavior, 43(6), 1165–1176. https://doi.org/10.1007/s10508-014-0263-

Table 1
Participant Table

Pseudonym	Age	Race/Ethnicity	Gender	Education	Relationship Status
John	18	Asian/Japanese	cisgender man	undergraduate student	single
JJ	21	Black	transgender man	high school	single
Nick	26	Black	cisgender man	bachelor's degree	long-term relationship
Sebastian	21	Chicano/Mexican	cisgender man	undergraduate student	long-term relationship
George	20	Asian/Filipino	cisgender man	undergraduate student	single
Ben	25	Black/White	cisgender man	graduate student	married
Kerry	20	Black/White	cisgender man	undergraduate student	single
Vance	30	Black	cisgender man	bachelor's degree	single

Table 2

Research Questions and Themes

Research Question	Themes
What attitudes about plurisexuality are prevalent in the lived experiences of plurisexual men of color?	1. Feeling Pressure to "Pick a Side" 2. One's Partner Determining "True" Sexuality 3. Plurisexual Individuals as More Promiscuous and Less Committal
How do participants understand and describe the intersection of their identities as they pertain to their day-to-day experiences?	1. Primacy of Racial and Transgender Identities 2. Racial Identities Bolstering Ideals of Masculinity 3. Gender Differences in Plurisexual Experiences
What, if any, perceived benefits do participants experience based on their race/ethnicity, gender, and sexual orientation identity?	1. Social Support and Community 2. Individuality and Empowerment

Homelessness in LGBTQ+ Emerging Adults: Understanding Perspectives and the Role of Family

Mackenzie R. Kent, Julia O. Matos, Libby Rianda, Bridget A. Walsh, and Sarah Mitchell
Department of Human Development and Family Studies, University of Nevada, Reno

Author Note:
Work on this project was supported by the following individuals and organizations: Kevin Carman, Ph.D., Debra Moddelmog, Ph.D., Patrick Agnello Sr., Raine Hanley, and Spectrum Northern Nevada.
Correspondence addressing this article should be addressed to Bridget A. Walsh, Professor Human Development and Family Studies, University of Nevada, Reno
Email: bridgetw@unr.edu

Abstract

LGBTQ+ emerging adults may experience homelessness for a myriad of reasons, including those related to family. This qualitative study included reflexive thematic analysis of in-person interviews with LGBTQ+ emerging adults (*N* = 10) between the ages of 18 and 29 years who identified as homeless. Findings suggest challenges directly connected to housing instability, family relationships, and mistreatment due to oppression targeting minority identities. The study focused on three areas related to family and home, which included homeless LGBTQ+ emergingadults' 1) perspectives regarding family, 2) perspectives regarding home, and 3) experiences that shaped perspectives of family and home. Findings highlight how participants view their families of origin compared to their families of choice, noting feelings of acceptance, safety, and a sense of familial ties once able to establish a supportive family of choice. The combined perspectives of family and home allow for an encompassing viewpoint on how participants shaped their own definitions of both home and family.

Keywords: emerging adults, family, home, homelessness, LGBTQ+

Homelessness in LGBTQ+ Emerging Adults:

Understanding Perspectives and the Role of Family

Of the homeless youth population residing within the United States, roughly 35% self-identifies as LGBTQ+, yet there is limited research on this historically marginalized population (Cochran et al., 2002). Previous studies (e.g., Anderson, 1996; Parker & Mayock, 2019; Shelton, 2016) have explored the impact of homelessness on emerging adults, defined as those between the ages of 18 and 29 years (Arnett, 2003). While there exists a myriad of complex and systemic factors that relate to homelessness (Shelton et al., 2018), one of the main reasons for homelessness in emerging adults is family conflict (Cull et al., 2006; Shelton et al., 2018). More specifically, LGBTQ+ emerging adults frequently state that homelessness is a result of family conflict revolving around sexual and/or gender identity (Shelton & Bond, 2017). The present study employs interview methods to investigate homeless LGBTQ+ emerging adults' perspectives regarding family, interpersonal relationships, and experiences.

The description of being homeless refers to any individual who lacks housing or consistent residency, has primary residence at night in a shelter or private facility, or who resides in transitional housing (U.S. Department of Health and Human Services, 2007). Because homelessness is experienced in a variety of ways, the conditions that qualify one as “homeless” are often unclear. In the present study, “homeless” describes participants who are sleeping or residing: in a shelter, motel, or vehicle; on the street; in an abandoned building; at the residence of friends, acquaintances, etc. (couch surfing), or in a program or otherwise detained.

Emerging Adulthood and LGBTQ+

According to Vinney (2018), the emerging adult period (Arnett, 2003) allows for identity examination before having to make long-term adult commitments. During the emerging adult developmental period, it is typical for individuals to explore their sexuality and gender expression (Maas et al., 2015). Emerging adults may express higher dependence upon their family of origin as this developmental period is often a time of instability, both financially and emotionally (Goldsmith, 2018).

The existing literature underscores the risks for LGBTQ+ emerging adults experiencing homelessness (Shelton et al., 2018). LGBTQ+ emerging adults may have experiences similar to their heterosexual and cisgender peers, but also risk experiencing additional discrimination from their families, peers, and others (Shelton et al., 2018). These emerging adults are especially at risk if they are dealing with familial or personal mental health issues, physical abuse, or delinquent behaviors (U.S. Department of Health and Human Services, 2007). This may in turn lead to a disruption in the family system that can result in challenges for the LGBTQ+ individual. The present study is an opportunity to understand the family context of emerging adults who identify as LGBTQ+ and homeless by examining their perceptions of family.

Family Perspectives: Emerging Adults Experiencing Homelessness

The Family Systems Theory (Bowen, as cited in Brown, 1999) interlocks ideas of how relationships are impacted by different life events, such as experiencing homelessness or coming out as queer. To further expand, Family Systems Theory views relationships as separate entities that work together to influence each other in terms of emotions, survival, and success (Bengtson et al., 2005). It is theorized that, by having one family member within the system who is not thriving on a social, emotional, or financial level, the rest of the system will be impacted through stress, lack of employment, or financial issues (Bengtson et al., 2005). Family systems influence how families react when a member of the family comes out as LGBTQ+ and/or when one experiences homelessness, and thus influence individual family members’ behavior. The stress of family systems disagreeing with one’s sexuality, coupled with not knowing where a homeless family member is located, puts strain on the relationships between other family members (Bengtson et al., 2005).

Studies have highlighted that household disruption, characterized as conflict, violence, and a lack of permanency (i.e., moving to different locations), are the basis for why emerging adults become or have already experienced homelessness (Anderson, 1996; Parker & Mayock, 2019; Shelton, 2016). These characterizations have involved the homeless individuals’ families. However, only a limited number of studies directly analyze the families’ perceptions of their homeless family members. Specifically, Parker and Mayock’s (2019) longitudinal study in Ireland examined the theme of “what family means” to the homeless 16-24-year-old population and their families. Participants were 40 homeless youth recruited from both statutory and non-statutory services in Dublin and 10 participant family members (Parker & Mayock, 2019). Parker and Mayock (2019) found that there were eight participants (four family members and four homeless individuals) who viewed “family as reliable and supportive,” indicating that both the homeless individual and family member demonstrated a correlation of positive meaning about one another. It was found that a number of homeless individuals experienced a lack of material and emotional support from their family members, which led them to perceive their family members as “interrupted and broken” (Parker & Mayock, 2019). In relation to household disruption, Parker and Mayock (2019) found that for many homeless individuals and family members, relationships were “fragile and elusive,” due to a lack of stability within their homes or past placement in formal or informal care settings.

In addition to homeless emerging adults, Shelton’s (2016) qualitative study explored homelessness with an emphasis on transgender and gender-expansive young people. Specifically, Shelton (2016) assessed risk and strength-based approaches. A sample of 27 homeless-identifying transgender and gender-expansive young adults, ages 18 to 25 years, were recruited from outside organizations that worked directly with the LGBTQ+ population (Shelton, 2016). The researcher used a phenomenological approach, which explores how individuals make sense of their experiences and how they apply those experiences to reality (Patton, 2002). Shelton (2016) found that several participants indicated that being homeless and identifying with others in similar situations provided a sense of belonging and strength.

Ryan et al. (2009) reviewed questionnaires that asked closed-ended questions to 224 LGB-identifying white and Latino adults ages 21-25 years of age. Transgender participants were not included in the study. These questions examined how negative family reactions to a young adult’s sexual orientation and gender identity are linked to health concerns in LGB young adults (Ryan et al., 2009). The findings suggest that young adults who are close to one family member and/or parental figure and scored highly on the “Family Rejection” portion of the survey (0 = never, 1= ever), were more likely to experience suicide attempts, high levels of depression, illegal drug use, and unprotected sexual intercourse (Ryan et al., 2009). The researchers also found that white women experienced no negative reactions as compared to Latino men, who experienced the highest number of negative family reactions to their sexual orientation in adolescence (Ryan et al., 2009).

The findings obtained from existing studies (e.g., Parker & Mayock, 2019; Ryan et al., 2009) provide necessary suggestions for further research when it comes to homelessness in emerging adults and specific sub-populations. The current study employs Shelton’s (2016) method of interview questions to help the field gain greater insights on family factors as an influence on LGBTQ+ emerging adults’ homelessness. Although there is existing literature on the perspectives of homeless emerging adult population and sub-populations, such as LGBTQ+people (Anderson, 1996; Parker & Mayock, 2019; Ryan et al., 2009; Shelton, 2016), there is a lack of research that explores LGBTQ+ emerging adults’ perceptions of family. The current study explores perspectives about family and home with the ambition that the family field will gain a better understanding of interpersonal relationships regarding homelessness in LGBTQ+ emerging adults.

Previous studies have explored homelessness in LGBTQ+ youth (Anderson, 1996; Parker& Mayock, 2019; Shelton, 2016). The current study focuses on emerging adults, ages 18 to 29 years, who identify as LGBTQ+ and are homeless. Informed by previous research regarding homeless LGBTQ+ individuals, our study focuses on three areas: their perspectives about family (Parker & Mayock, 2019), their perceptions of home (Shelton, 2016), and the experiences that shaped those perspectives of family and home (Shelton, 2016). Research demonstrating LGBTQ+ emerging adults’ perspectives about family is limited. This qualitative study addresses three research questions:

RQ1: What are homeless LGBTQ+ emerging adults' perspectives of family?

RQ2: What are homeless LGBTQ+ emerging adults' perspectives on home?

RQ3: What experiences with family have shaped the perspectives of family and home for LGBTQ+ emerging adults?

Method

Participants

A total of 10 homeless, LGBTQ+-identifying emerging adults between the ages of 18-29 years were recruited from two organizations (hereafter referred to as Shelter 1 and Shelter 2) across two states in the Western United States. These shelters' Program Directors allowed the researchers to speak in person with their participants, and both shelters were serving LGBTQ+ individuals at the time of the study. Data were collected between November 2019 and February 2020. The COVID-19 pandemic limited the number of participants and sites where data could be safely collected. Shelter 1 allowed for 3 participants, and travel to Shelter 2 allowed for access to 10 more participants (See Table 1 for participants' demographic data).

Context

Shelter 1 was an LGBTQ+-specific center located in the Southwestern United States that serves both youth and young adults. This organization did not act as a drop-in homeless shelter but did offer an off-site housing program and regularly catered to individuals facing homelessness. In addition to offering some basic needs such as food and shelter, Shelter 1 offered education-based and workforce-related resources, along with multiple resources regarding health. Unlike Shelter 1, Shelter 2 offered 24-hour services and was not a LGBTQ+-specific shelter. Instead, this organization was a homeless shelter that provided youth and young adultswith emergency shelter and additional necessities. This shelter offered life skills classes, workforce training, and healthcare resources.

Procedures

Demographic information regarding consenting participants' race(s), ethnicity(ies), age, education level, gender identity, and sexual orientation was collected at the start of the study through paper surveys and recorded interviews (see Table 1). After completion of the demographic survey, participants were invited to complete the interview phase. Confidentiality of participants was protected through the use of pseudonyms to disguise participant identities. Site names were not utilized in order to avoid participant identification. Original copies of surveys were destroyed after data were analyzed.

The semi-structured interview guides were reviewed by six Ph.D.-level experts prior to data collection to promote content validity. Interview questions were minorly revised according to feedback provided by the experts. Homeless LGBTQ+ emerging adult participants were individually interviewed using a semi-structured and in-depth approach that lasted approximately 60 to 90 minutes per individual. The interview script for participants consisted of 17 topic questions and 45 sub-questions. Eight topic questions were adapted from Shelton (2016) to understand the participants' experiences related to both their sexual orientation/gender identity and their experiences being or having been homeless. Our research adapted, with permission, a total of 23 of Shelton's (2016) guided interview questions to better fit the homeless LGBTQ+ emerging adult population while probing about specific topics. This number includes both topic and sub-questions. Parker and Mayock's (2019) study was used as a reference for questions regarding family perspectives. Both studies (Parker & Mayock, 2019; Shelton, 2016) were used to fulfill the purpose of exploring a homeless LGBTQ+ emerging adult's idea of family. Eight questions used to elicit biographical narrative were included to prompt participants to recall or recreate their lives through "story telling" (Parker & Mayock, 2019). Each question related to emerging adults has been adapted from Shelton's interview guide (2016) and edited to focus on interpersonal relationships with an expansion on feelings of "home." Examples of Shelton's (2016) guiding questions include: "What was it like to be (use their identifier relating to gender) specifically; How has that affected your life up to this point; Tell me about a time you felt homeless; What were your relationships like at that time (friends, lovers, family)." At the end of the interview, each participating homeless LGBTQ+ emerging adult was given a $15.00 gift card to thank them for their participation. All interviews were audio recorded and transcribed verbatim.

Researcher Reflexivity

Researcher reflexivity (see Allen, 2000) was promoted throughout the study to ensure there was minimal intentional and/or unintentional influence on the results from the researchers. According to Jootun et al. (2009), understanding the biases, identities, and positions held by the researchers helps to ensure a higher caliber of qualitative research. Prior to data collection, the researchers journaled their experiences and assumptions about LGBTQ+ individuals and homelessness. Reflexivity continued throughout the interview and data analysis process. Researchers created memos following exchanges with participants to highlight reactions and key aspects of each interview. During coding and thematic analysis, researchers talked through language and interpretation of codes used to ensure themes were neutral and accurately reflected the participant's verbalized experiences. Three authors identify as part of the LGBTQ+community and the third and fourth authors identify as LGBTQ+ allies.

Data Analysis

Descriptive statistics were calculated for the demographic questions. Interview data were analyzed using a reflexive thematic analysis approach (Braun & Clarke, 2006). Analysis was accomplished by uploading the transcripts to Dedoose version 8.3.45 (2020), a web-based qualitative data analysis software. The rigor of the analysis was ensured by triangulation among three analysts (see Patton, 2002), who worked both individually and together on the data analysis; periodic meetings were also held with a fourth team member to ensure intercoder agreement (Campbell et al., 2013). Analysts individually read the transcripts to become comfortable with the data and then individually identified and generated codes for each transcript (Braun & Clarke, 2006). The analysts discussed their initial reading and codes, and then reached consensus on codes using a negotiated agreement approach where differences in codes were discussed during team meetings until all disagreements were rectified (Campbell et al., 2013).

The three analysts then met with a fourth team member who had also read and coded the transcripts; an amended codebook was created based on the consensus of the four researchers. Individual coding of transcripts continued, and team discussions were initiated when new codes were deemed necessary based on data in subsequent interviews. The coding scheme was adjusted, and the researchers returned to previously coded transcripts to ensure codes were applied accurately. This process continued, and coding was finalized when the researchers agreed that no new codes appeared in any transcripts. Over several meetings, the analysts discussed the finalized set of codes and grouped them into subthemes and then emergent themes

(Braun & Clarke, 2006).

Results

Three themes emerged that addressed the research questions: 1) perspectives regarding family, 2) perspectives regarding home, and 3) experiences that shaped perspectives regarding family and home. In Table 2, we list and provide representative quotes for each subtheme.

Perspectives Regarding Family (Theme 1)

Our first research question considers the homeless LGBTQ+ emerging adults' perspectives regarding family. Participants identified two distinct categories when describing family, those being the family of origin and the subsequent chosen family created after separation from one's family of origin. Thus, the two sub themes include*:* (a) family of origin as unsupportive/unaccepting and (b) chosen family as important/necessary.

Although participants may currently have some contact and/or communication with their family of origin, every participant described an overall lack of family support and acceptance. The sentiment expressed most often by participants on this topic resembled a statement by Mario, "My parents were not very supportive of [identifying as LGBTQ+]." A few participants shared in Malik's perspective, "I knew that [my family] were homophobic." Participants expressed feeling similar to Laura in that they "did not feel accepted."

Furthermore, participants felt unsupported by their family of origin when it came to their lack of housing stability. Laura stated, "I [would] try to ask [my father] for help [with housing] and he didn't help me." This lack of family support regarding homelessness was generally described as a side effect of participants not being supported due to their LGBTQ+ identities. Mario illustrated this when stating:

> Imagine, imagine waking up one day and all your family is just gone...You have no one to call, nowhere to go. You don't know what tomorrow will bring, you don't know whereyour next meal is going to come from. You don't know if you're going to eat, if you're going to survive, what to do. You have no one to turn to, to ask questions, you just deal with it.

According to some participants, this lack of support went beyond their LGBTQ+ and homeless status and into their overall needs. Jackie stated that, "I wasn't being supported at all."Lorne asserted that their family was "very dysfunctional and very hard to deal with." Some participants described this dysfunction as taking the form of "abuse and neglect," which exacerbated perceptions of lacking support. Participants also expressed how they believe their lives could have differed if their family of origin would have been more accepting and supportive. Jackie, a transgender woman stated, "I mean, if my family was accepting and supported me and helped me in my journey, I probably would have had a better, you know, life."

Regarding the second subtheme, chosen family as important/necessary, all participants indicated that they have created family units outside of their family of origin. Generally, participants defined these types of family units as "chosen family." All identified their "chosen family as important" to them and some made the distinction of "chosen family as necessary." Participants characterized those in their chosen family "as individuals who have been supportive," commonly using descriptive terms such as, "trustworthy" and "safe."

According to participants, support surrounding LGBTQ+ status and housing instability were some of the biggest prerequisites for being considered "chosen family" members. Jacob mentioned, "[I] have friends that really helped me out because of them being accepting of the LGBTQ community." For Jacob and most other participants, the support from their chosen family went beyond acceptance of LGBTQ+ status and into physical support. While talking about his best friend, he states, “She helped me through the hardest of times and she is like family to me.”

Participants often stated that their chosen family made them feel safe and secure, both physically and emotionally. When talking about their friendships, Morgan stated, “Just having, um, friends around, but keeps me feeling safe, like I'm not alone.”

Perspectives Regarding Home (Theme 2)

Regarding the homeless LGBTQ+ emerging adults’ perspectives on home, two sub-themes emerged: (a) a tangible physical presence and (b) an intangible entity dependent on feelings of safety.

Temporary living situations disclosed by participants, in their own words, include: “I couch surf a lot;” “I stay on the streets;” “I’m living in my car;” “We’re in a weekly motel;” and,“I’m in a shelter.” Most participants listed some tangible items when asked about their perspectives on home and what the term home means to them. Miles stated, “In order for someone to feel like it's home, they truly have to have their own space... your own place to lay your head, you know, obviously your own furniture and your own clothes and etcetera.” Laura adds, “A place that's bug free and... central air and heat... a kitchen cause we don't have that. And a full fridge.”

Intangible ideas of home identified by participants included “feelings of safety” in their environment and the idea that people can feel like home. For those who frequented homeless shelters, there existed a constant fear that, while they were sleeping, their few belongings would be stolen by other homeless individuals.

Participants also stated that they felt more able to nurture relationships with friends and family when having a permanent residence. When physical shelter is not available, the participants mentioned that the trusted people in their lives, their “chosen family,” often feel like home. Jordan stated, “[A home] doesn't even have to be physical because I mean it's, it's the people that you surround yourself with.” Because physical stability is so fleeting, the idea of “home” is viewed as more than a tangible location. The majority of descriptions given by participants combined the tangible and intangible views of “home” to create an ideal of a safe, physical shelter where their loved ones had access or also resided. Mario stated,

> Home is not necessarily a place. It's the people you surround yourself with... You can always find somewhere to go and feel nice and feel comfy, safe, cozy, but without the people that love you and care for you. It's nothing. It's just a place.

Mario highlighted how, by establishing an environment where the people within a chosen family are supportive and create a feeling of safety, individuals are able to establish a sense of emotional stability.

Experiences that Shaped Perspectives Regarding Family and Home (Theme 3)

The perspectives regarding family held by the participants were shaped through experiences with both their (a) family of origin and (b) chosen family.

Experiences shaped participants’ perceptions of their families of origin as unsupportive and unaccepting. Many participants chose to hide their sexual orientation or gender identity from their family of origin. This was often due to participants knowing that their family was not accepting of the LGBTQ+ community. Jacob states, “Their own brother [my uncle] was out. He's gay too. I knew how my grandma was towards him when he came back. She was totally against it. She kicked him out of the house." Others, like Lorne, are treated poorly following "coming out." He asserted, "My grandma calls all gay people faggots. And she'll just do that [to me] randomly." The act of "coming out" to family of origin often resulted in being disowned or kicked out of the house, as was the case for James: "My adopted mom found out I was gay at a young age, you know, and she disowned me." Sometimes support was so fleeting after coming out to family members that leaving was viewed as the safest option. Jackie recounts:

> I could not sit through something [lack of support/acceptance from family of origin] that was literally causing me to kill myself. I tried to kill myself twice as a child. So like there's just really no other option but to leave.

This lack of support is generally worsened by or grounded in their family's religious beliefs, which underlined many parents' unsupportive behaviors. While talking about their "coming out" experience, Jacob said: "[My father] blamed himself for me being gay because hesaid he shouldn't have gone on his own to become a preacher and stuff and this is God's way of that punishing him (is) to have a gay son." Malik further expanded on the role of religion in his experience with his family when he said, "So my parents are very religious... My identity really did clash with that. You know. Okay. You know, I found it's hard to like [to] try to come out to them. And they were very not supportive of it."

Some of these unsupportive experiences were not focused on the LGBTQ+ identities of the participants. A few participants had a family of origin where abuse and dysfunction were the norm, regardless of their LGBTQ+ identity or homeless status. According to participant Laura, "My step-dad was trying to hit me because I blacked out from an epileptic seizure, but I didn't know that [it] was an epileptic seizure at the time 'cause I wasn't fully diagnosed." Others were in and out of group homes and foster care following events with their family of origin. Mario recounted, "I was adopted to them at three... in and out of group homes. I've been arrested because of my adoption mom [on] three different accounts."

Regarding the subtheme of experiences involving chosen family, the experiences expressed by participants involving their chosen family centered around support, both tangible and intangible. Physical backing often took the form of housing, as Morgan stated when referencing their friendships and living situation, "The house I'm in right now, which is my friend and his family, I consider them my family there... Um, just being around them... makes me feel more secure…"

In addition to physical support, experiences with chosen family also involved less tangible backing. Participants expressed that their chosen family accepted that they identified with the LGBTQ+ community, often because those individuals also identify with the community. As upheld by Morgan, "My closest friends are in my community—of the LBGTQ community as well." Sometimes this support took the form of guidance or kindness. Laura described an individual who took on this role, "Bus station mama, one of the security guards of the bus station, she really is [who] looked out for us. She was really nice..."

Discussion

The primary purpose of the present research was to identify and thematically analyze homeless LGBTQ+ emerging adults' perspectives regarding family, perspectives on home, and experiences that shaped perspectives regarding family and home. By answering the questions associated with these topics, researchers can understand such lived experiences in order to potentially improve the services provided by homeless shelters, LGBTQ+ shelters, and related organizations.

Our first theme, Perspectives Regarding Family, is corroborated by the existing literature. The present study found that participants viewed family of origin as overall unsupportive and unaccepting.

Participants viewed their family life as unstable, with a lack of both tangible and intangible support. These results echo the Parker and Mayock (2019) study finding that homeless individuals considered family as “interrupted and broken.” As with the current study, participantsfelt that their family relationships were dysfunctional (Parker & Mayock, 2019). Because Parker and Mayock (2019) focused on homeless individuals, not homeless LGBTQ+ individuals, findings around LGBTQ+ identity cannot be corroborated. However, the present study found that this lack of support extended to the participants’ LGBTQ+ identity. For many participants, the absence of backing from their family of origin regarding their LGBTQ+ identity served to amplify the lack of support in other areas of their lives.

The strain placed on the participant’s relationships with their family of origin concords with the principles of Family Systems Theory (Bengtson et al., 2005). According to this theory, major life events for one individual in the family can have a lasting effect on the other members and the relationships between members of the family (Bengtson et al., 2005). For some participants, this strain in the family system existed before they revealed their gender identity or sexual orientation. The current study found that this revelation often led to additional tension, which was a precursor to the participant leaving or being disowned by their family of origin. Pulling from Family Systems Theory, this already present strain between family members led to stress for both the participant and the rest of their family of origin (Bengtson et al., 2005).

Chosen families were viewed by participants as an important source of feelings of acceptance, safety, and emotional support that were lacking from their families of origin. This result aligns with Shelton’s (2016) finding that, by connecting with other people in similar circumstances (i.e., homeless or LGBTQ+), people can create a sense of security and acceptance not experienced elsewhere. For homeless individuals, these chosen families enable feelings of emotional stability and physical safety contrasting against the alternative of living alone on the streets. Chosen families also hold the ability for individuals to affirm their gender identity and/or sexuality whereas their family of origin may not have. Our second theme, Perspectives on Home, indicates that there is a sense of “community” among people classified as homeless, which also aligns with existing literature (Parker & Mayock, 2019; Shelton, 2016). Shelton (2016) reported that a number of participants indicated that being homeless and identifying with others in a similar situation provided a sense of belonging and strength. Our findings corroborate this view and add nuance by showing that this sense of belonging can be viewed as an intangible entity, such as “feeling safe” within their chosen family or broader community. Parker and Mayock’s (2019) similarly found that young homeless adults experienced “family-like-relationships” within shelters or informal care. Our findings also align with other studies indicating that some individuals view their home—and not being homeless—as a risk factor (Anderson, 1996; Parker & Mayock, 2019; Shelton, 2016).

Although our study and others emphasize the intangible aspects of what “home” means to participants, such as having emotional connections with those who identify similarly and/or who are going through similar experiences, there was also a large connection between the idea of “home” and more physical, tangible aspects. Many of our participants discussed the impact of having an actual roof over their head or items that they “owned,” such as furniture, clothing, and food. Our study suggests that a perspective on home cannot be described exclusively as tangible or intangible; rather, there are multiple aspects of defining a sense of home that are synonymous with both intangible and tangible things. This implies that although some participants were given shelter through resource centers or by staying with friends, these places did not satisfy the idea of home.

Our review of the literature found an overall lack of sources regarding the homeless LGBTQ+ communities' viewpoint on home. The present study suggests that the tangible views of home tend to focus on aspects that are lacking due to homelessness (i.e., own personal space, own furniture, a refrigerator and groceries). The intangible meaning of home seems to be representative of experiences surrounding lack of acceptance, support, or security. These may be due to aspects of homelessness, but also the disruptive and dysfunctional relationships in the homes of their upbringing/family of origin. Future research should focus on the connection between ideas of home and past experiences.

Our third and final theme, Experiences that Shaped Perspectives Regarding Family and Home, captured multiple experiences that shaped an individual's perspectives regarding family and home. Although Ryan et al. (2009) focused on LGBTQ+ young adults and family rejection, they did not expand upon how rejection and mental health affect those who have been "kicked out" or end up leaving because of the trauma of coming out to their family of origin. The present study uncovered the aftermath of what can occur when someone leaves their family of origin. We found that participants reported impacts from negative family experiences and that the LGBTQ+ emerging adults' experience disparities when seeking support services. However, unlike Ryan et al. (2009), the present study also focused on the idea of "chosen families" and found that chosen families were viewed by participants as a way to establish feelings of acceptance, safety, and emotional support that may compensate for the lack thereof from their family of origin.

Limitations

There are some limitations of our study. First, selection of participants for this study was accomplished through convenience sampling; individuals residing within the same and neighboring states were recruited for the study due to their proximity to the researchers. Therefore, our study data may not be generalizable to the whole population of homeless LGBTQ+ emerging adults. Second, participant recruitment was limited by the COVID-19 pandemic. Scheduled sites where researchers initially intended to gather data were required to close due to the outbreak of the pandemic. These closures limited our total number of participants and prevented us from completing follow-up interviews. Third, the study included one interview at one point in time; emerging adults may encounter shifts in their experiences, in their LGBTQ+ identities, and with their experiences of homelessness. We were not able to capture data on these potential shifts. Fourth, this study focused specifically on the perspectives of LGBTQ+ emerging adults, limiting the understanding of the family system when compared to individuals not within this population.

Conclusion

The present study had a strong focus on the overall lack of family support experienced by participants. Many participants seemed to use their chosen family to fill a gap left by or that was never filled by their family of origin. To bolster support for homeless LGBTQ+ individuals, strengthening of all family types should be a target in subsequent research. Future research may utilize the Intersectional Family Systems Framework (Schmitz et al., 2020) to accurately capture or explain multiple aspects of LGBTQ+ individuals' experiences with homelessness. Crenshaw (1989), who coined the term "intersectionality," pointed out the unique and multiplicative impacts of interlocking systems of oppression based on gender and race in the lives of black women. Applying this framework to families of all types and structures, it will be important for future research to consider how interlocking systems of oppression based on gender, race, age, disability, and other personal identifiers affect those in the LGBTQ+ community. By rethinking labels such as “the LGBTQ+ experience” or “the homeless experience,” which collapse nuance and suggest the existence of consistent monoliths of experience, researchers can better understand and ultimately support homeless LGBTQ+ emergent adults.

References

Allen, K. R. (2000). A conscious and inclusive family studies. *Journal of Marriage and theFamily, 62,* 4-17. https://doi.org/10.1111/j.1741-3737.2000.00004.x

Anderson, D. G. (1996). Homeless women's perceptions about their families of origin. *Western Journal of Nursing Research, 18*(1), 29-42. https://doi.org/10.1177/019394599601800103

Arnett, J. J. (2003). Conceptions of the transition to adulthood among emerging adults in American ethnic groups. *New Directions for Child and Adolescent Development, 100*,63–75.

Bengtson, V. L., Acock, A. C., Allen, K. R., Dilworth-Anderson, P., & Klein, D. M. (2005).Theory and Theorizing in Family Research: Puzzle Building and Puzzle Solving. In V. L. Bengtson, A. C. Acock, K. R. Allen, P. Dilworth-Anderson, & D. M. Klein (Eds.), *Sourcebook of family theory & research* (p. 3–33). Sage Publications, Inc.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research inPsychology, 3*(2), 77-101.

Brown, J. (1999). Bowen Family Systems Theory and Practice: Illustration and Critique. *Australian and New Zealand Journal of Family Therapy, 20*(2), 94-103.https://doi:10.1002/j.1467-8438.1999.tb00363.x

Campbell, J. L., Quincy, C., Osserman, J., & Pedersen, O. K. (2013). Coding In-depth Semistructured Interviews: Problems of Unitization and Intercoder Reliability and Agreement. *Sociological Methods & Research*, *42*(3), 294–320. https://doi.org/10.1177/0049124113500475

Cochran, B. N., Stewart, A. J., Ginzler, J. A., & Cauce, A. M. (2002). Challenges Faced by Homeless Sexual Minorities: Comparison of Gay, Lesbian, Bisexual, and Transgender Homeless Adolescents With Their Heterosexual Counterparts. *American Journal of Public Health, 92*(5), 773-777. https://doi.org/10.2105/ajph.92.5.773

Crenshaw, Kimberlé. (1989). Demarginalizing the intersection of race and sex: A Black Feminist critique of antidiscrimination doctrine, Feminist Theory, and antiracist politics. *University of Chicago Legal Forum*, 139–167.

Cull, M., Platzer, H., & Balloch, S. (2006). Out on my own: understanding the experiences and needs of homeless lesbian, gay, bisexual and transgender youth. *Brighton: Health and Social Policy Research Centre.*

Dedoose Version 8.3.45, web application for managing, analyzing, and presenting qualitative and mixed method research data [computer software] (2020). Los Angeles, CA: SocioCultural Research Consultants. www.dedoose.com

Goldsmith, J. (2018). *Emerging adults' relationships with their parents.* https://www.family-institute.org/sites/default/files/pdfs/csi-emerging-adults-relationships- with-parents.pdf

Jootun, D., McGhee, G., & Marland, G. R. (2009). Reflexivity: promoting rigour in qualitative research. *Nursing standard (Royal College of Nursing (Great Britain) : 1987)*, *23*(23), 42–46. https://doi.org/10.7748/ns2009.02.23.23.42.c6800

Maas, M. K., Shearer, C. L., Gillen, M. M., & Lefkowitz, E. S. (2015). Sex rules: Emerging adults' perceptions of gender's impact on sexuality. *Sexuality & Culture*, *19*(4), 617–636. https://doi.org/10.1007/s12119-015-9281-6

Parker, S., & Mayock, P. (2019). “They're always complicated but that's the meaning of family in my eyes:" Homeless youth making sense of "family" and family relationships. *Journalof Family Issues, 40*(4), 540–570. https://doi.org/10.1177/0192513X18812512

Patton, M. Q. (2002). Qualitative research and evaluation methods (3rd ed.). Sage Publications.

Ryan, C., Huebner, D., Diaz, R. M., & Sanchez, J. (2009). Family rejection as a predictor of negative health outcomes in white and latino lesbian, gay, and bisexual young adults. *Pediatrics, 123* (1), 346-352. https://doi:10.1542/peds.2007-3524

Schmitz, R. M., Robinson, B. A., & Sanchez, J. (2020). Intersectional Family Systems Approach: LGBTQ+ Latino/a youth, family dynamics, and stressors*. Family Relations,69,* 832-848. https://doi.org/10.1111/fare.12448

Schweitzer, R. D., Hier, S. J., & Terry, D. (1994). Parental bonding, family systems, and environmental predictors of adolescent homelessness. *Journal of Emotional and Behavioral Disorders, 2*(1), 39-45. https://doi.org/10.1177/106342669400200105

Shelton, J. (2016). Reframing risk for transgender and gender-expansive young people experiencing homelessness, *Journal of Gay & Lesbian Social Services, 28*(4), 277-291, https://doi.org/10.1080/10538720.2016.1221786

Shelton, J., & Bond, L. (2017). "It just never worked out": How transgender and gender expansive youth understand their pathways into homelessness. *Families in Society: The Journal of Contemporary Social Services, 98*(4), 284-291. https://doi.org/10.1606/1044-3894.2017.98.33

Shelton, J., DeChants, J., Bender, K., Hsu, H., Maria, D. S., Petering, R., Barman-Adhikari, A.(2018). Homelessness and housing experiences among LGBTQ young adults in seven U.S. cities. *Cityscape, 20*(3), 9-34.

U.S. Department of Health and Human Services. (2021). *Understanding homelessness: Frequently asked questions.* https://nhchc.org/understanding-homelessness/faq/

Vinney, C. (2018). *Emerging Adulthood: The "in-between" developmental Stage*. https://www.thoughtco.com/emerging-adulthood-developmental-stage-4175472

Table 1

Demographic Characteristics of Participating LGBTQ+ Emerging Adults

Characteristics	n	%
Gender Identity		
Cisgender female	1	10.0
Cisgender male	5	50.0
Genderfluid	1	10.0
Transgender female	1	10.0
Transgender male	2	20.0
Race/Ethnicity		
Asian	0	0.0
Black	2	20.0
White	4	40.0
Hispanic/Latinx	2	20.0
Biracial	2	20.0
Sexual Orientation		
Bisexual	4	40.0
Heterosexual	3	30.0
Homosexual	2	20.0
Pansexual	1	10.0
Highest educational level		
Middle school/some high school	4	40.0
High school/some college	6	60.0
Associate's degree/Bachelor's degree	0	0.0

Postgraduate degree	0	0.0
Living Situation		
In a vehicle	1	10.0
On the street	3	30.0
Couch surfing	2	20.0
In a shelter	2	20.0
In a weekly motel	2	20.0
Unsafe Home Life		
Disownment	4	40.0
Homophobia/transphobia in the home	8	80.0
Foster System/adoption	5	50.0
Experienced homelessness before age 18	6	60.0

Table 2

Themes and Corresponding Subthemes

Themes (Sub) Themes	Representative quotes
Perspectives Regarding Family (Theme 1)	"My parents were not very supportive of [idenitifying as LGBTQ+] so growing up I had to hide that for most of my life until finally I said fuck it. "It's like when gay marriage was legalized, they have an opinion on it... I knew that they were homophobic. That was all I needed to know" (Malik). "Uh, I've been ostracized from my family. I haven't seen my siblings in five years. Mmm. My mom hardly talks to me. Mmm. No one respects my pronouns, let alone my name. Mmm. No one respects. I don't feel accepted" (Laura). "If I didn't pay my rent for my weekly motel, I [would] try to ask [my father] for help and he didn't help me. He spent his money at the racetrack and stuff, so that shows you where I don't get any help, so it's okay" (Laura). "Imagine, imagine waking up one day and all your family is just gone... You have no one to call, nowhere to go. You don't know what tomorrow will bring, you don't know where your next meal is going to come from. You don't know if you're going to eat, if you're going to survive, what to do. You have no one to turn to, to ask questions, you just deal with it" (Mario). "I wasn't being supported... I know that just kind of we're trying to erase my existence and you know, keep me away from the other family and isolate me so... yeah" (Jackie).

	“Rocky and, uh, very, very dysfunctional. Like as I lived with my mom off and on until 13, and then ended with my biological dad and he started kicking me out. And then he would report me as a runaway. And then, um, he would, after he would report me as a runaway, I get picked up for the police after a while, and then they'd send me back and then he would beat me and then kicked me out, and then the cycle will continue. So it was very dysfunctional and very. Hard to deal with” (Lorne). “I just always existed the way I existed. So I don't think there's anything I could try to change. I mean, if my family was accepting and supported me and helped me in my journey I probably would have had a better, you know life” (Jackie). “[I] have friends that really helped me out because of them being accepting of the LGBTQ community'. I have friends in the LGBTQ community. They consider themselves bi (bisexual) or gay. I had a lot of gay and bi friends at school or even lesbian. So I hang out with them” (Jacob). “My one friend she was really helping (me) through it because she experienced [being removed from her family of origin] with her own family... I wouldn't believe I'd be here today because she helped go through the depression I had. She helped me through the hardest of times and she is like family to me”(Jacob). “It just has enough, um, friends around, but keep me feeling safe, like I'm not alone... And um, they're just like, they're like, the door is open if you want to come in basically kind of thing. And it makes me feel like I don't have to, if I don't want to. And they're not forcing me to do anything, but they're giving me the

	option. Okay. And I like that. And then also it's just where I belong" (Morgan). "Home feels like safety. Somewhere you can look [forward] to going home to rest and stuff" (Jacob). "Home means I'm happy. Wherever I'm safe or more over, I'm pursuing what I want to do, where I'm able to focus" (Morgan).
Perspectives on Home (Theme 2)	"To be honest with you, in order for someone to feel like it's home, they truly have to have their own... in your own space, your own place to lay your head, you know, obviously your own furniture and your own clothes and etcetera, you know your own personal TV. I feel like that's truly being at home and being able to be comfortable because think about it"(Miles). "To have a place that's safe and stable that is accessible and not just for living, but for like transportation and for say, like I said, safe. So. That's bug free and, and, um, clean. And if it's multiple floors or working elevator. And cause our elevator doesn't work. And central air and heat, we don't have that. And you know, yeah. A kitchen cause we don't have that. And a full fridge. Cause that would be nice" (Laura). "[A home] doesn't even have to be a physical because I mean it's, it's the people that you surround yourself with" (Jordan). "Home is not necessarily a place. It's the people you surround yourself with... You canalways find somewhere to go and feel nice and feel comfy, safe, cozy, but without the people that love you and care for you. It's nothing. It's just a place" (Mario).
Experiences that Shaped Perspectives Regarding Family and Home (Theme 3)	"Their own brother [my uncle] was out. He's gay too. I knew how my grandma was towards him when he came back. She was

	totally against it. She kicked him out of the house. I wanted to come out to her because I really needed her at that moment" (Jacob). "Um, my grandma calls all gay people, faggots. And she'll just do that [to me] randomly and she'll like, if she sees them on TV or anything, um, my uncle and my biological dad will will be very disrespectful about, um about anyone who's different and they'll be all over Facebook about how they'll be hateful. They'll comment on my posts about how, cause I'll post things on Facebook about how I support gay rights and stuff like that. And they'll be like, 'Why? What's the point? They don't deserve to have the same rights' and all that" (Lorne). "My father was against [identifying as LGBTQ+]. He blamed himself for me being gay because he said he shouldn't have gone on his own to become a preacher and stuff and this is God's way of that punishing him (is) to have a gay son" (Jacob). "But yeah, I could not sit through something that was literally causing me to kill myself. I tried to kill myself twice as a child. So like there's just really no other option but to leave so yeah" (Jackie). "You know, it's like the clash between religion and my identity. Yeah. So my parents are very religious. You know, they tried to run a pretty religious household and well, my identity really did clash with that. You know. Okay. You know, I found it's hard to like try to come out to them. And when they, and when I eventually did, it wasn't really by choice. It was more like they found out. And, um, I guess their reaction was almost like disappointment, you know? And they were very not supportive of it." (Malik)

	"My step dad was trying to hit me because I blacked out from an epileptic seizure, but I didn't know that was an epileptic seizure at the time cause I wasn't fully diagnosed. Um, because I wasn't watching my, my autistic brother. Um, he was getting into something in the kitchen." (Laura) "Yeah. I know the, the house I'm in right now, which is my friend and his family, I consider them my family there. I did the tour for my friend when he decided to come here. Oh. So I came here before him and he came here. So I was the one touring and then I recommended him to go to the school I go to, and that's how we started a friendship. It just boom. There it is. So then I think that's really cool. Um, just being around them like make you feel more secure and do they make you feel like you have a home and like. Yes. Their home is your home. Yup." (Morgan) "I, I have some close friends. My closer friends are in my community of the LBGTQ community as well. So it's good. I don't really have a lot of other friends cause I typically stay to myself in school, but when I found this community, I came like a social butterfly.I was like, who is this child?" (Morgan) "Hopefully the ones that we made recently will stay. Um, um, we've, we've had like, as we jokingly say, bus station mama cause the, one of the security guards of the bus station, she really is look out for us. She was really nice. Um, and let's see. Uh, Oh, the, one of the people at the shelter, like you find some really nice motherly figures when you're out on the streets and, and you're young and that's really nice." (Laura)

Using Markov Chains to Outline Probability of Alcohol Dependence in Alcoholics

Jacob Freed & Deena Schmidt
Department of Mathematics and Statistics, University of Nevada, Reno

Abstract

Markov Chains (MCs) are models used to create realistic descriptions of real-world systems, in which an agent of the system transitions between a current and future state dependingon a probability matrix. In this study, we use the programming language R to simulate MCs, as well as a modified version of this model that includes actions and multiple probability matrices to model decision making. More specifically, the simulation describes the transition of alcoholics between states of drinking moderately (M), binge drinking (B), and not drinking (N) over each week of 1 year, 2 years, and 10 years. It should be noted that these simulations have a variety of "conditions", such as each entry of the probability matrices, as well as the actions and policy that dictate which probability matrix to use in a given time step (modified MC only). Because of the various societal and health benefits of quitting an alcohol addiction, we hypothesized that under the correct conditions, simulations would yield an overall transition of states M and B to state N over the course of a year.
Keywords: Markov Chain, Policy, States, Probability Matrix, Actions

Introduction

Alcoholism, more formally defined as Alcohol Use Disorder (AUD), impacts up to 14.5 million Americans ages 12 and older (National Institute on Alcohol Abuse and Alcoholism, 2022). However, there is no medically recognized threshold for how much drinking constitutes this disorder (American Psychiatric Association, 2013). Instead, a variety of symptoms generate a criterion by which medical professionals can diagnose such a condition (American Psychiatric Association, 2013). Because of this variability in AUD, it is important to highlight the differences in treatment for this condition in different individuals. That is, treatment may involve a variety of medical professionals, as well as medications, mutual support groups, and behavioral therapy (National Institute on Alcohol Abuse and Alcoholism, 2021). More specifically, some combination of primary care physicians, social workers, alcohol counselors, psychiatrists, and psychologists may be needed to effectively treat AUD (National Institute on Alcohol Abuse and Alcoholism, 2021). Although these forms of treatment may appear different, it has been shown through previous research that treatment works for AUD - about ⅓ of people who seek treatment for AUD have no symptoms after one year (National Institute on Alcohol Abuse and Alcoholism, 2021). In this paper, we model the effectiveness of treatment for AUD, specifically by comparing the frequency and severity of drinking in response to treatment using a simulation defined by different probability models. We hypothesize that going to treatment will have beneficial outcomes on the frequency and severity of drinking, and that barriers to treatment will have the opposite effect.

There are many factors that may increase the chance of continuing or worsening the progression of AUD - one of which would be having alcoholic friends (Groh et al., 2007). It has been shown that decreased consumption of alcohol in social settings and increased support from friends to stop AUD predicts less alcohol use (Groh et al., 2007). Therefore, by having alcoholic friends, we can model an individual as less likely to quit drinking and more likely to partake in heavier alcohol consumption. We can also define a situation in which a person with AUD does not take any particular action for or against AUD - which would result in an intermediate probability of continuing to abuse alcohol. At this point we have identified three key states for our Markov Chain model: not drinking, moderately drinking, and binge drinking, which allows us to define a Markov probability matrix.

A Markov probability matrix is part of a Markov Chain - a mathematical tool that models probabilities and their outcomes based on given states and the given matrix. Markov Chains have been used for a variety of applications - from modeling cell mitosis to urban expansion (Grewal, Krzywinski, & Altman, 2019) (Losiri et al., 2016). The Markov probability matrix functions by holding probabilities of transitioning from one state (represented by the row) to a future state (represented by the column). Let's consider a simple example to illustrate this. Suppose today's weather can be summarized into one of three classes: Raining, Snowing, or Sunny. Each day, the weather can transition between these states according to the following Markov probability matrix:

Columns → Rows ↓	Raining	Snowing	Sunny
Raining	0.75	0.2	0.05
Snowing	0.3	0.6	0.1
Sunny	0.1	0.1	0.8

In this example, this probability matrix means that the chance of raining tomorrow when it is raining today is 0.75, the chance of snowing tomorrow when it is raining today is 0.2, and the chance of being sunny tomorrow when it is raining today is 0.05.

In this work, we use Markov Chains to model the transition from week to week between the three states of not drinking (N), moderately drinking (M), and binge drinking (B). We define the time step as one week, meaning that state N is one week of not drinking, state M is one week of moderate drinking, and state B is one week of binge drinking. We run the simulation long enough to model one year, two years, and ten years. No drinking means no alcohol was consumed, while moderate drinking means drinking some alcohol strictly less than the threshold for constituting binge drinking. Binge drinking, finally, is defined as consuming four or more drinks in under two hours for women, and consuming five or more drinks in under two hours for men (National Institute on Alcohol Abuse and Alcoholism, 2022). The associated Markov probability matrix is given below.

$P =$

	N	**M**	**B**
N	*0.5*	*0.25*	*0.25*
M	*0.25*	*0.5*	*0.25*
B	*0.25*	*0.25*	*0.5*

In this Markov probability matrix, the second row describes the probability of transitioning from moderate levels of drinking in one week to not drinking at all the next week ($P_{MN} = 0.25$), moderate drinking again the next week ($P_{MM} = 0.5$), and binge drinking the next week ($P_{MB} = 0.25$).

We also consider a second model which is an extension of the first model described above. We modify the Markov Chain to include a Policy - a vector that includes probabilities of a given alcoholic seeking treatment, having alcoholic friends, or taking no action - conditions known as actions. This vector, using its entries, then selects a probability matrix that varies from action to action and maps out future states according to these probabilities. This modified Markov Chain is a simple version of a Markov Decision Process (MDP), a mathematical framework which includes actions, rewards, and a discount factor which can be used to predict outcomes based on the inclusion of these more complicated variables (Littman, 2001). To minimize assumptions about the quantitative value of rewards and their perception by alcoholics, this model seeks out the effect of actions and choices on outcomes, rather than their rewards or relation to time. In this model, the policy was largely based on the assumption that on a week to week basis, the largest probability is that alcoholics, wanting to get better, seek treatment (Moss,Chen, & Yi, 2007). A smaller inclination of many alcoholics is to remain dependent on alcohol, especially in regard to social situations. For example, alcoholics may be tempted to continue drinking and continue with friends based on the comorbidity of social anxiety disorder, in which alcoholics may perceive less tension in social situations while intoxicated (Book & Randall, 2002). We once again assume that taking no action falls in the intermediate of these two extremes, with an intermediate probability given in the policy.

Dependence on alcohol can be a variable experience but invariably causes harm to alcoholics, as well as their loved ones in many instances (Hardey et al., 2022). Through this experiment, we use previous research to inform assumptions about probabilities of drinking and severity of this behavior on a week to week basis. For the first model, we hypothesize that treatment is effective as a long-term solution for many alcoholics, as shown by decreasing rates of binge drinking and moderately drinking, and increasing rates of not drinking over the course of a year. Additionally, for treatment to be effective we hypothesize that these changes will appear with consistency as the year goes on, as opposed to relapsing at the end of the year. Opposite trends are expected for continuing to have alcoholic friends. For the second model (modified MC), we anticipate that because we assume probability for treatment is highest, a downward trend will be shown in drinking habits (both binge drinking and moderately drinking) over the course of one year, two years, and ten years. We expect the opposite trend to be seen for not drinking, and that not drinking will prevail as the more time-consuming state as the horizon of the modified Markov Chain expands.

Materials and Methods

This Markov Chain simulation of choices by alcoholics was executed with the programming language R. Two simulations were run: one that included three executions of MCs,and another with three executions of an MC with actions - that is, with multiple probability matrices for one year, two years, and ten years. To begin, we define a function of n iterations (weeks) with probability matrix P and beginning state x_1 set to moderately drinking, that is $x_1 = M$ and $n = 52, 104, 520$ (corresponding to 1, 2, and 10 years, respectively). We added the conditions that the variable m would be the number of columns of P (in this case, 3), and that x_1 would be random if not provided for the MC. A loop iterates through each time step up to n, choosing a new state randomly according to P.

Below we describe the details in each of the two model frameworks.

Model 1

For our first model, we create a function that is then executed three times: one execution models the scenario of not going to treatment, nor having alcoholic friends; one execution models the scenario of going to treatment for AUD; and one execution models the scenario of having alcoholic friends. For the first execution of this function, we set P (no action) equal to the matrix below:

P =

	N	***M***	***B***
N	*0.5*	*0.25*	*0.25*
M	*0.25*	*0.5*	*0.25*
B	*0.25*	*0.25*	*0.5*

with $n = 52$ iterations (as there are 52 weeks in a year), and $x_1 = M$ (the moderately drinking state). The function is run with these parameters and the resulting sample path was plotted, as well as the frequency of states visited in the form of a histogram (see Results). This corresponds to Model 1 with no action taken.

For the second and third executions of this function, we modify only the matrix P to P_t (treatment) and P_a (alcoholic friends) as shown below, corresponding to Model 1 with fixed matrix P_t or P_a respectively:

P_t =

	N	*M*	*B*
N	*0.6*	*0.3*	*0.1*
M	*0.5*	*0.4*	*0.1*
B	*0.4*	*0.5*	*0.1*

P_a =

	N	*M*	*B*
N	*0.1*	*0.5*	*0.4*
M	*0.1*	*0.4*	*0.5*
B	*0.1*	*0.3*	*0.6*

See Appendix for Model 1 Code, and the results will be discussed in the next section.

Model 2

For the second model (modified MC), we once again construct a function of *n* iterations, probability matrix *P*, starting state x_1 (set to the state of moderately drinking), and add in the variable *Policy*, which defines the probability of choosing each of the available actions (corresponding to probability matrices P_0, P_t, and P_a, where P_0 is the matrix from *P* from Model 1 which represents taking no action). Another difference between this model and the previous one is the use of a three dimensional matrix in R, which contains each of the previous three probability matrices above in one data structure. We denote this three-dimensional matrix as *P*. We once again set *m* to be the number of columns in the first "plane" of *P*, and define x_1 as a random state if not provided. We create a loop ending in *n*, which first selects an action based off of the probabilities entered through the *Policy* variable. Using this action, a plane of *P* is selected and a new state is randomly chosen according to the probabilities in this plane. For our execution of this function, *Policy* is set to the vector

Policy = [0.4 0.5 0.1],

where the entries correspond to the probabilities of taking no action, seeking treatment, and having alcoholic friends, respectively. We derive the *Policy* vector from the fact that many people with AUD are most likely to seek treatment, although exact probabilities may vary between individuals (Moss, Chen, & Yi 2007). Each plane of *P* is created from the probability matrices defined in the first model, where $P[,,1] = P_0$, $P[,,2] = P_t$, and $P[,,3] = P_a$. Iterations areset to $n = 52$ weeks per year. The function was run with these parameters, and a plot was constructed of each state over time, along with a histogram of the frequency of time spent in each state (see Results). These functions, plots, and histograms were then run again representing the passage of 2 years and 10 years, with $n = 104$ and $n = 520$ respectively. See Appendix for Model 2 Code.

Results

Each execution of the functions shown above provide the results of this experiment. For Model 1 with no action - that is, no preference of an alcoholic to select treatment or the acquisition of alcoholic friends - we find that binge drinking is less common than the other two states, but drinking in general (moderate or binge) makes up a significant portion of time steps (*~58%* of time steps) (Figure 1, Figure 2). Additionally, Figure 2 displays how the year ends in the state of not drinking, but this is not consistent. In other words, only the last one week of the year was spent not drinking in this execution of the simulation, as opposed to a longer, more stable period of not drinking (Figure 2). In the execution of Model 1 with the treatment probability matrix, however, a trend towards not drinking was clearly established (Figure 3, Figure 4). This is because the time spent in the not drinking state was highest in magnitude (*~63%* of time steps), whereas hardly any time was spent in the state of binge drinking (*~4%* oftime steps) (Figure 3, Figure 4). Additionally, the year ended with 7 weeks of not drinking, which indicates a more stable and long-term transition to this state (Figure 4).

Lastly, in the execution of Model 1 with alcoholic friends, we find that the majority of time is spent in moderately drinking or binge drinking (*~87%* of time steps) (Figure 5, Figure 6). We note that time spent in the binge drinking state in particular is larger than any of the other executions of this model, and almost matches the time spent moderately drinking given the condition of having alcoholic friends (Figure 1, Figure 3, Figure 5). We note that in this execution of the function, there is no pattern that ends the year - rather, there is a short-term (2 week long) return to moderate drinking (Figure 6). Finally, we note that there exists an asymmetry between the histograms of the treatment version and alcoholic friends version of the model; seeking treatment greatly reduced the time spent in the states of binge drinking and moderate drinking compared to no action, whereas having alcoholic friends greatly increased the time spent in the states of binge drinking and moderate drinking compared to no action, as well as significantly reducing the time spent in the state of not drinking (Figure 1, Figure 3, Figure 5).

In Model 2 - the MC with three different actions, the simulation was executed over the time span of 1 year, 2 years, and 10 years. In the first simulation, the addition of actions with the given policy yielded a result similar to the “no action” simulation of the typical MC (Model 1, no action) - binge drinking had the lowest (yet still reasonably high) frequency (*~12%* of time steps), whereas the states of not drinking and moderately drinking were almost equal and together took up the majority of time in the simulation (*~88%* of time steps between the two) (Figure 1, Figure 7). However, the 2 year and 10 year simulations depict almost exactly the same pattern, in which not drinking took up the largest amount of time, followed by moderately drinking, followed by binge drinking (Figure 8, Figure 9). It should be noted that although time spent moderately drinking and time spent binge drinking decreases, they still occupy a significant portion of the simulated years (*~58%* of the time steps between the two) (Figure 8, Figure 9).

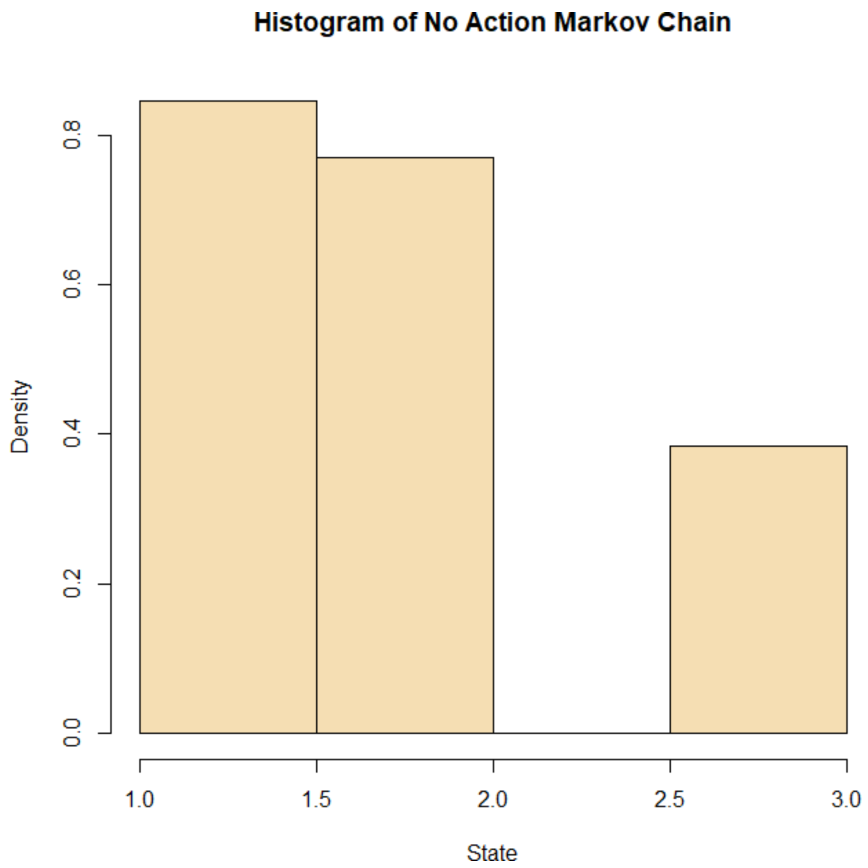


Figure 1. Histogram of No Action Markov Chain. This histogram displays the frequency of each state (not drinking, moderately drinking, and binge drinking for states 1, 2, and 3 respectively) under the condition that a given alcoholic seeks out neither treatment nor alcoholic friends.

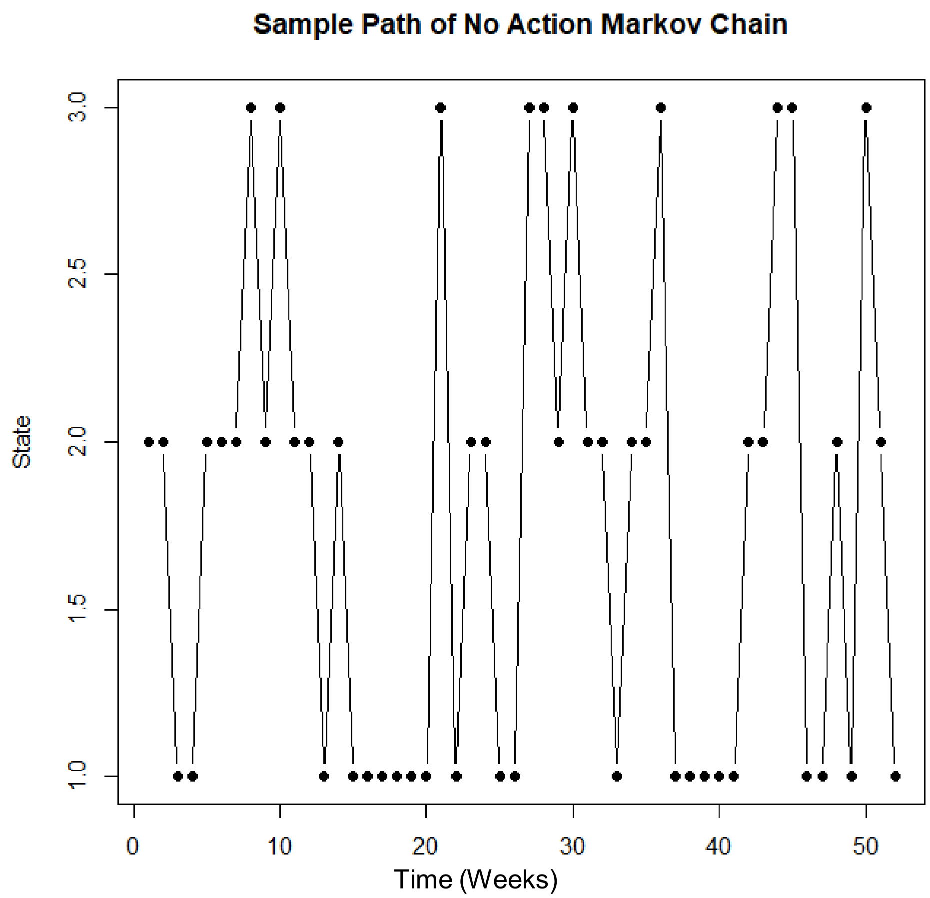


Figure 2. Sample Path of No Action Markov Chain. This is another visual representation of the progression of states over a given number of weeks, where state 1 is not drinking, state 2 is moderately drinking, and state 3 is binge drinking. This is under the condition that a given alcoholic seeks out neither treatment nor alcoholic friends.

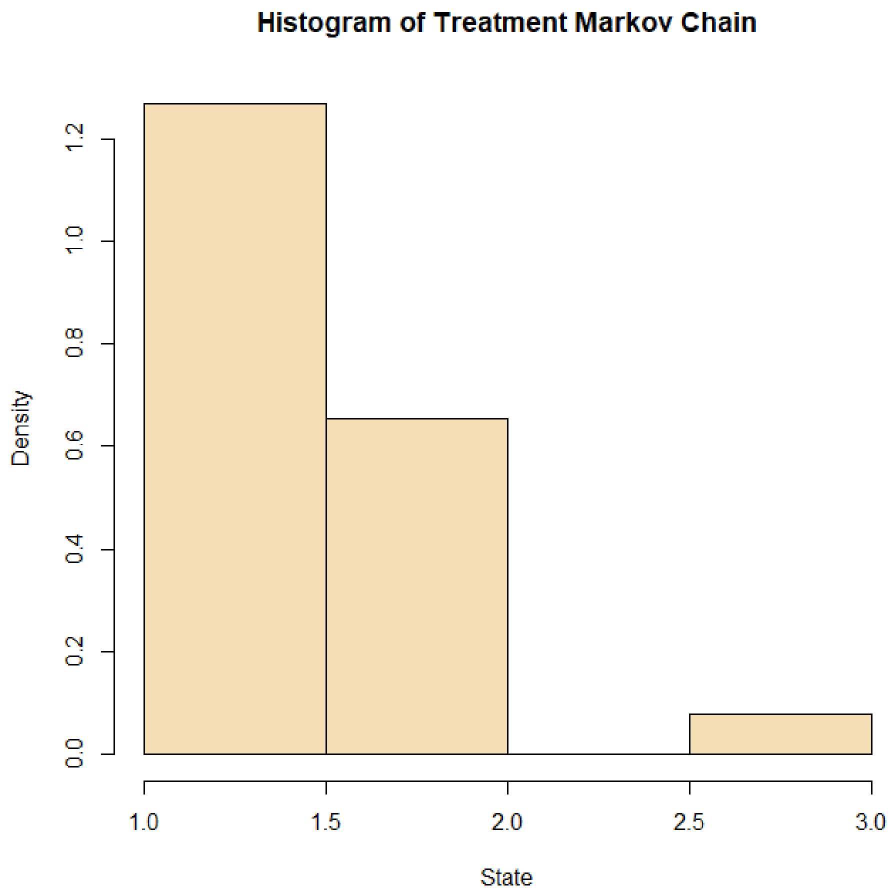


Figure 3. Histogram of Treatment Markov Chain. This histogram displays the frequency of each state (not drinking, moderately drinking, and binge drinking for states 1, 2, and 3 respectively) under the condition that a given alcoholic seeks out treatment.

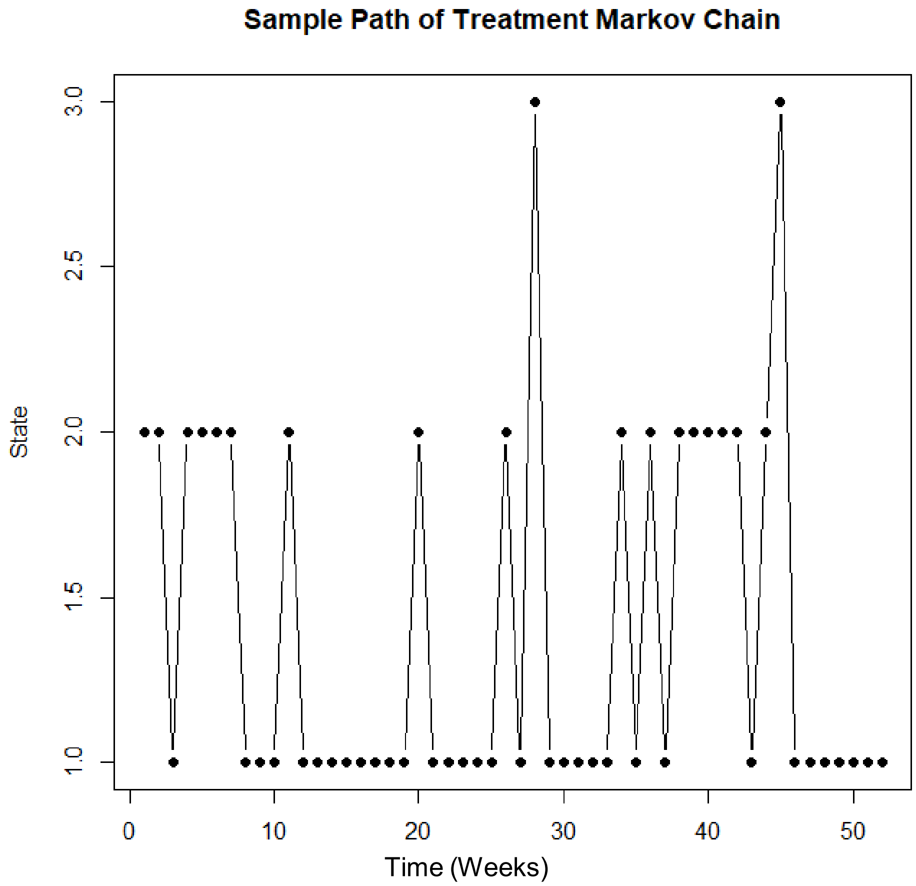


Figure 4. Sample Path of Treatment Markov Chain. This is another visual representation of the progression of states over a given number of weeks, where state 1 is not drinking, state 2 is moderately drinking, and state 3 is binge drinking. This is under the condition that a given alcoholic seeks out treatment.

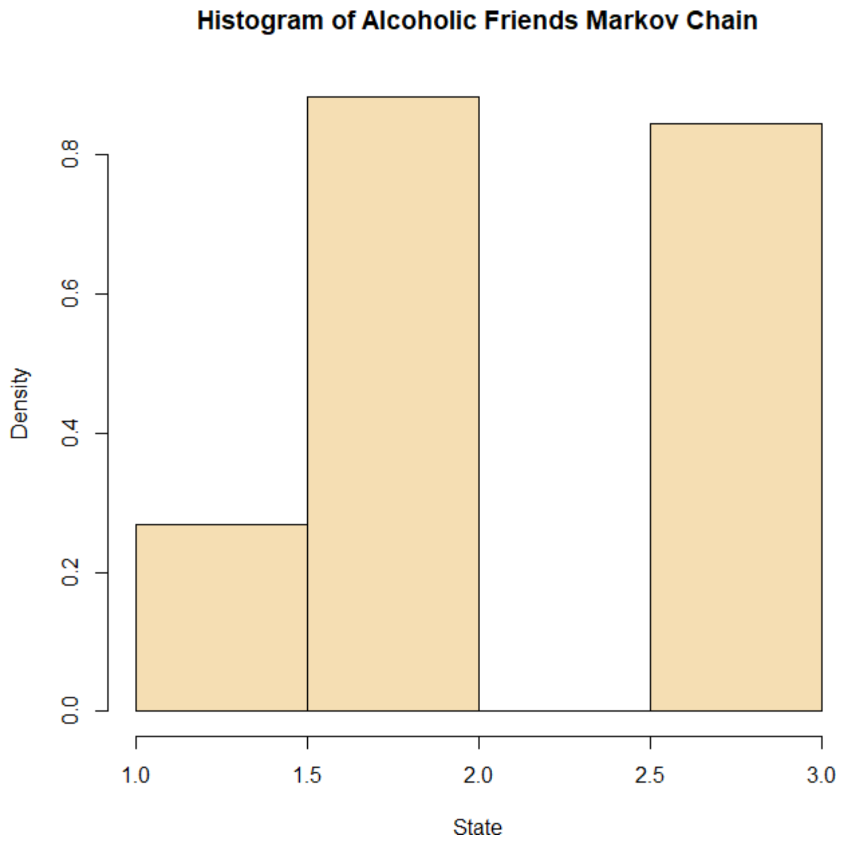


Figure 5. Histogram of Alcoholic Friends Markov Chain. This histogram displays the frequency of each state (not drinking, moderately drinking, and binge drinking for states 1, 2,and 3 respectively) under the condition that a given alcoholic seeks out alcoholic friends.

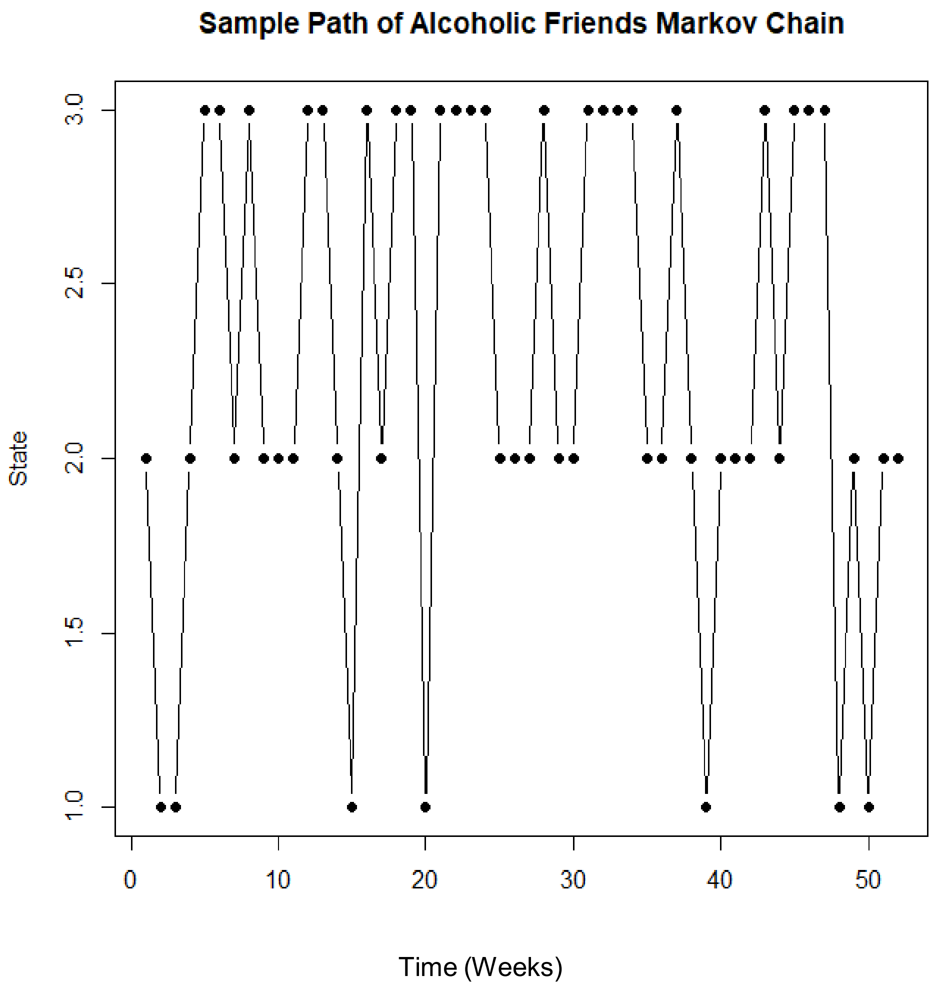


Figure 6. Sample Path of Alcoholic Friends Markov Chain. This is another visual representation of the progression of states over a given number of weeks, where state 1 is not drinking, state 2 is moderately drinking, and state 3 is binge drinking. This is under the condition that a given alcoholic seeks out alcoholic friends.

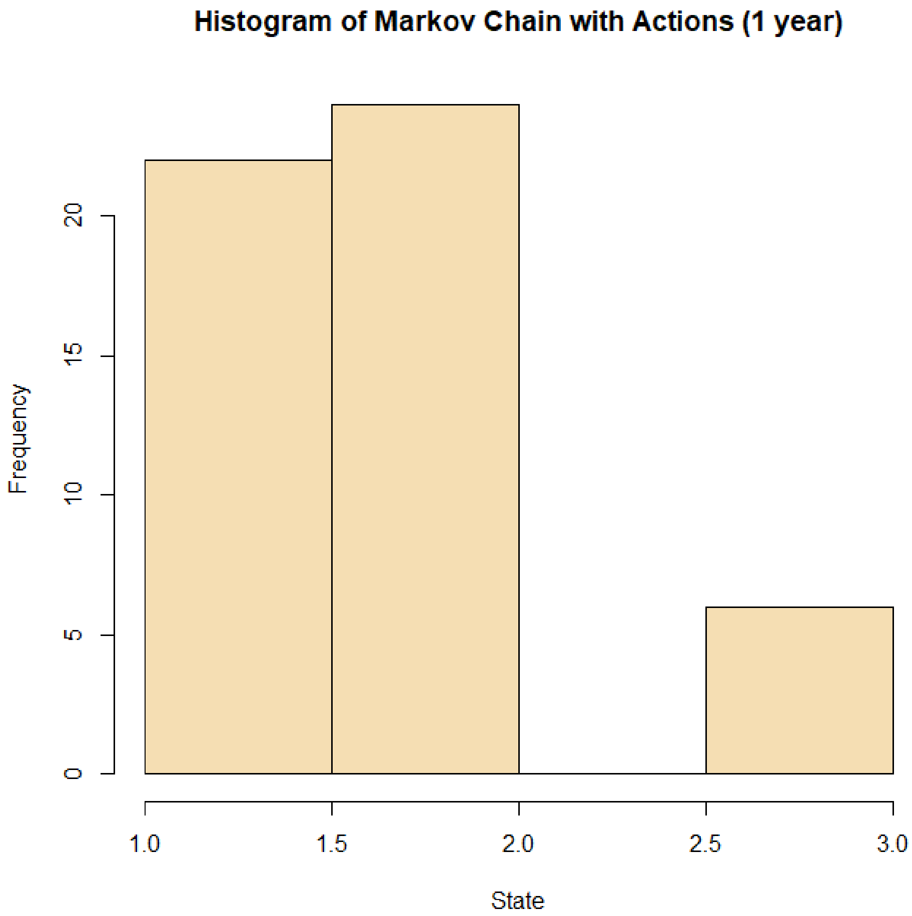


Figure 7. Histogram of Markov Chain with Actions (1 Year). This histogram displays the frequency of each state (not drinking, moderately drinking, and binge drinking for states 1, 2, and 3 respectively) over the course of one year given that the probability matrices change with different actions of the alcoholic.

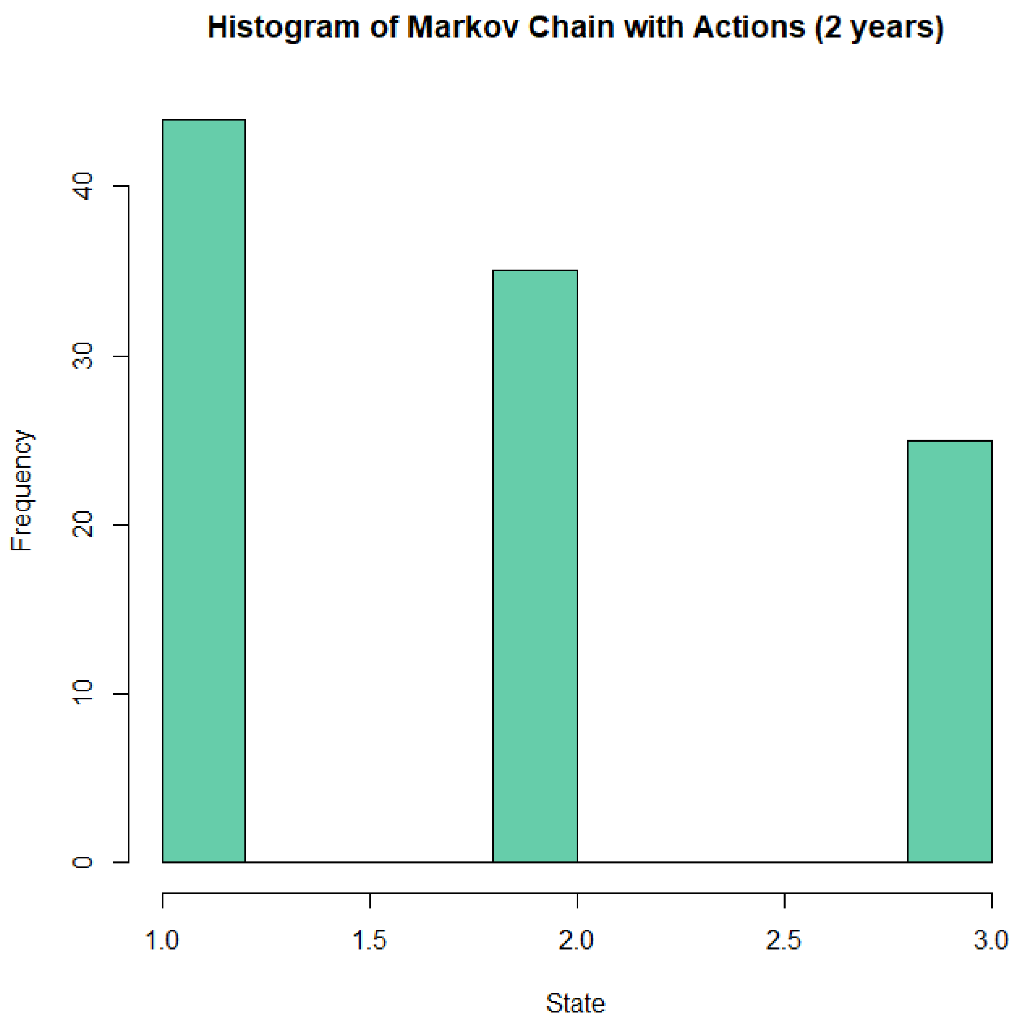


Figure 8. Histogram of Markov Chain with Actions (2 Years). This histogram displays the frequency of each state (not drinking, moderately drinking, and binge drinking for states 1, 2, and 3 respectively) over the course of two years given that the probability matrices change with different actions of the alcoholic.

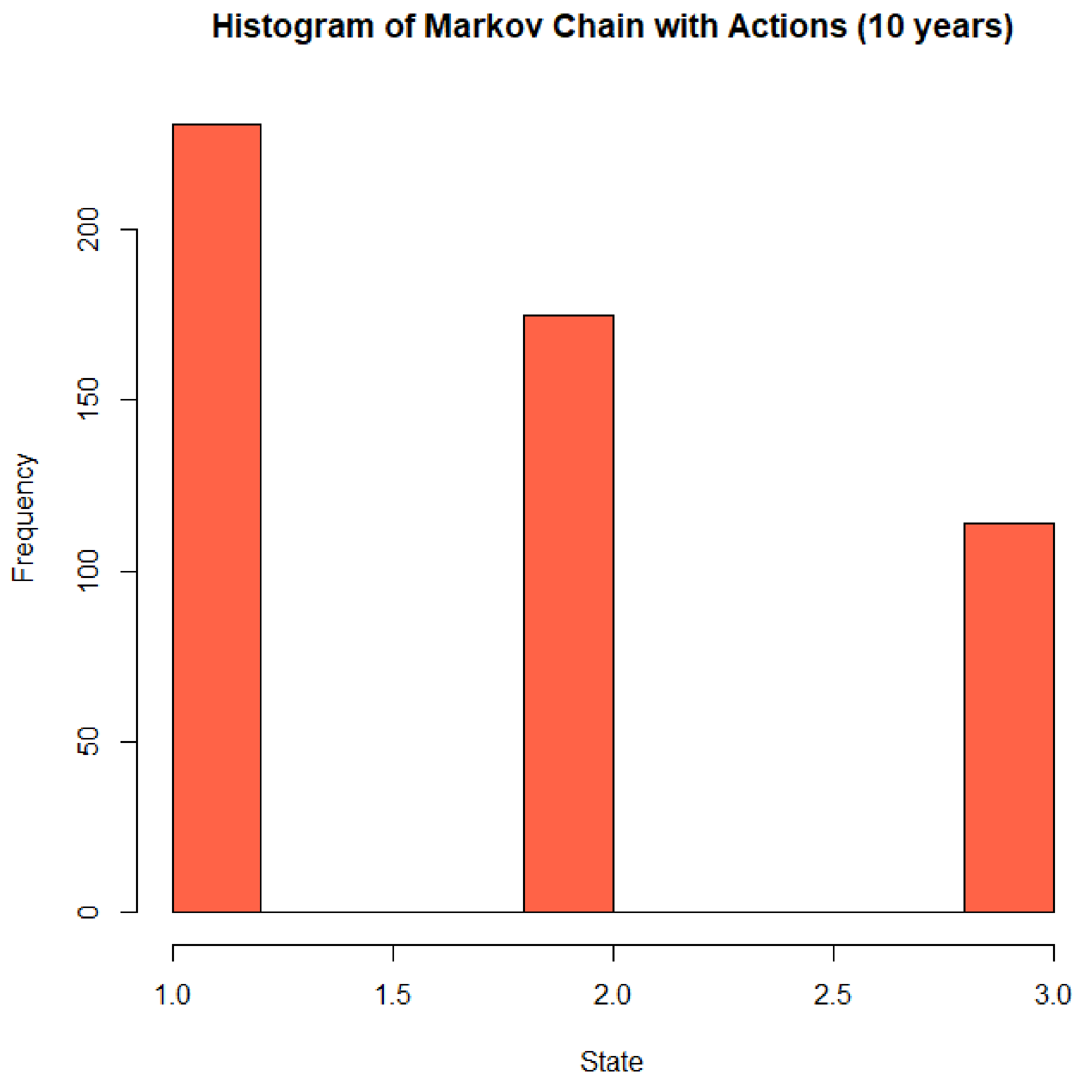


Figure 9. Histogram of Markov Chain with Actions (10 Years). This histogram displays the frequency of each state (not drinking, moderately drinking, and binge drinking for states 1, 2, and 3 respectively) over the course of ten years given that the probability matrices change with different actions of the alcoholic.

Discussion

It follows from the results of this simulation that seeking treatment for addiction such as alcoholism will result in longer-term transitions towards not drinking. Similarly, participating in actions such as having alcoholic friends will increase the time spent drinking over the course of a year, compared to the control in this experiment of taking part in no action. This provides evidence for our initial hypotheses regarding the effectiveness of treatment and the damage done by avoiding it. However, the results of this study also highlight how having variability in the choice of action leads to no significant changes in drinking habits over the course of years. Overall, this supports our hypothesis for the first model, but not our second model. These results indicate that alcoholics having a choice to either go to treatment, have alcoholic friends, or participate in neither action do not necessarily result in better outcomes, even over long time periods, given the policy that was simulated. It could very well be the case that having these actions in our model, which better approximate reality, can still result in more time spent in the not drinking state, but the differences in probability for actions given by the policy must be starker. That is, it is not enough to have treatment be the most likely option, it must be the action with the highest probability by over 50%.

This finding is significant because it demonstrates how treatment and recovery for AUD is complicated. Seeking treatment may seem to be an obvious starting point for many alcoholics and medical professionals, but this experiment shows it is only a powerful tool if used consistently and appropriately. If the only option is to seek treatment, those with AUD are likely to recover, but when given even a small set of choices/actions, it is possible to continue substance abuse for years into the future. These considerations are not meant to undermine the importance of treatment for AUD, but rather serve as a guide to understand the importance of consistency in treatment - for those impacted by AUD as well as medical professionals treating it. Those with AUD should be advised that consistency in treatment is a key factor in recovery,and those treating AUD should be advised that lack of motivation for said consistency may be one of the most misunderstood and impeding obstacles.

There are many areas for improvement in the application of Markov Chains to substance abuse. For these Markov Chains, many of the probabilities and the policy were estimates or assumptions, as definite probabilities about week to week transitions of those with substance abuse are not yet available. However, these estimates were informed by overall trends in behavior of those with AUD, and continue to represent possible outcomes for many alcoholics as a result. For these models to be more realistic, more research must be done on the overall attendance of those with AUD to treatment, the type and extent of treatment, as well as probabilities and severity of drinking over time steps smaller than one year. These efforts in future research could be easily implemented into the current models presented in this paper, which would elucidate the process of recovery for AUD further - both for those afflicted and for those seeking to treat AUD.

References

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). American Psychiatric Publishing.

Book, S. & Randall, C. (2002). *Social Anxiety Disorder and Alcohol Use.* National Institute on Alcohol Abuse and Alcoholism. https://pubs.niaaa.nih.gov/publications/arh26-2/130-135.htm

Grewal, J., Krzywinski, M., & Altman, N. (2019). Markov models - Markov chains. *NatureMethods, 16*(8), 663-664. https://doi.org/10.1038/s41592-019-0476-x

Groh, D. et al. (2007). Friends, Family, and Alcohol Abuse: An Examination of General and Alcohol-Specific Social Support. *Am J Addict, 16*(1), 49-55. 10.1080/10550490601080084

Hardey, S. et al. (2022, August 28). *Alcohol Use Disorder and Family/Marital Problems.* American Addiction Centers. https://americanaddictioncenters.org/alcoholism-treatment/family-marital-problems

Littman, M. (2001). Markov Decision Processes. *International Encyclopedia of the Social & Behavioral Sciences,* 9240-9242. https://doi.org/10.1016/B0-08-043076-7/00614-8

Losiri, C. et al. (2016). Modeling Urban Expansion in Bangkok Metropolitan Region Using Demographic - Economic Data through Cellular Automa-Markov Chain and Multi-Layer Preceptron-Markov Chain Models. *Sustainability, 8*(7), 686. https://doi.org/10.3390/su8070686

Moss, H., Chen, C., & Yi, H. (2007). Subtypes of Alcohol Dependence in a Nationally Representative Sample. *Drug Alcohol Depend, 91*(2-3), 149-158.10.1016/j.drugalcdep.2007.05.016

National Institute on Alcohol Abuse and Alcoholism. (2021, August). *Treatment for Alcohol Problems: Finding and Getting Help.* National Institute on Alcohol Abuse and Alcoholism. https://www.niaaa.nih.gov/publicationsbrochures-and-fact-sheets/treatment-alcohol-problems-finding-and-getting-help

National Institute on Alcohol Abuse and Alcoholism. (2022, March). *Alcohol Facts and Statistics.* National Institute on Alcohol Abuse and Alcoholism. https://www.niaaa.nih.gov/publications/brochures-and-fact-sheets/alcohol-facts-and-statis tics

Appendix

Model 1 Code: This code outlines the simulation of a Markov Chain for three different matrices. One to model the sample path and frequency of drinking while taking no action for AUD, one to model the sample path and frequency of drinking while going to treatment for AUD, and one to model the sample path and frequency of drinking while having alcoholic friends.

```
#The following lines define the Markov Chain function, with inputs of number of iterations, the probability matrix, and the initial state:
MC.sim <- function(n,P,x1)
 {sim <- as.numeric(n)
 m <- ncol(P)
 if (missing(x1)) {
  sim[1] <- sample(1:m,1)
 }

 else {
  sim[1] <- x1
 }

 for (i in 2:n) {
  newstate <- sample(1:m,1,prob=P[sim[i-
  1],])sim[i] <- newstate
 }

 sim
}


#The following lines define the probability matrix for taking no action:
P = matrix(c(0.5,0.25,0.25,0.25,0.5,0.25,0.25,0.25,0.5), nrow = 3, byrow =
TRUE)P

#The following lines define the initial state and the number of iterations, and run the function with these parameters (taking no action):
x1 = 2
n = 52
MC.sim(n,P,x1)
run1 <-
MC.sim(n,P,x1)
X11();
#The following lines code for the plotting of the sample path and histogram of the different states of drinking over the course of a year:
plot(run1, type = "b", pch = 19, main = "Sample Path of No Action Markov Chain", xlab =
"Time", ylab = "State")
X11();
hist(run1, col = "wheat", main = "Histogram of No Action Markov Chain", xlab = "State", freq =
F)

#The following lines define the probability matrix for going to treatment:
```

```
Pt = matrix(c(0.6,0.3,0.1,0.5,0.4,0.1,0.4,0.5,0.1), nrow = 3, byrow =
TRUE)
Pt

#The following lines define the initial state and number of iterations, and run the simulation
with these parameters (going to treatment):
x1 = 2
n = 52
MC.sim(n,Pt,x1)
run2 <-
MC.sim(n,Pt,x1)
X11();
#The following lines code for the plotting of a sample path and histogram of the different
states of drinking over the course of a year:
plot(run2, type = "b", pch = 19, main = "Sample Path of Treatment Markov Chain", xlab
="Time", ylab = "State")
X11();
hist(run2, col = "wheat", main = "Histogram of Treatment Markov Chain", xlab = "State", freq =
F)

#The following lines define the probability matrix of having alcoholic
friends:Pa = matrix(c(0.1,0.5,0.4,0.1,0.4,0.5,0.1,0.3,0.6), nrow = 3, byrow =
TRUE)
Pa

#The following lines define the initial state and number of iterations, as well as run the
function with these parameters (having alcoholic friends):
x1 = 2
n = 52
MC.sim(n,Pa,x1)
run3 <-
MC.sim(n,Pa,x1)
X11();
#The following lines code for the plotting of a sample path and histogram of the different
states of drinking over the course of a year:
plot(run3, type = "b", pch = 19, main = "Sample Path of Alcoholic Friends Markov Chain", xlab
= "Time", ylab =
"State")X11();
hist(run3, col = "wheat", main = "Histogram of Alcoholic Friends Markov Chain", xlab =
"State", freq = F)
```

Model 2 Code: This code outlines the simulation of a Markov Chain with actions in which there is a chance of switching between three matrices - one to model no action taken, one to model going to treatment, and one to model having alcoholic friends. This simulation then outlines the sample path and frequency of drinking considering this combined probability matrix.

```
#The following lines define the Markov Chain function with actions, and includes the number
ofiterations, a 3-Dimensional probability matrix, the initial state, and the Policy:
MC.sim <-
  function(n,P,x1,Policy){sim <-
```

```
  as.numeric(n)
  m <- ncol(P[,,1])
  if(missing(x1)){
    sim[1] <- sample(1:m,1)
  }

  else{
    sim[1] <- x1
  }

  for(i in 2:n){
    Action <- sample(1:3, 1, prob = Policy)
    newstate <- sample(1:m, 1, prob = P[sim[i-
    1],,Action])sim[i] <- newstate
  }

  sim
}

#The following lines define the 3-Dimensional probability matrix representing taking no
action,going to treatment, and having alcoholic friends:
P <-
array(0,c(3,3,3))
#P0
P[,,1] <- matrix(c(0.5,0.25,0.25,0.25,0.5,0.25,0.25,0.25,0.5),3,3)
#Pt
P[,,2] <- matrix(c(0.6,0.5,0.4,0.3,0.4,0.5,0.1,0.1,0.1),3,3)
#Pa
P[,,3] <-
matrix(c(0.1,0.1,0.1,0.5,0.4,0.3,0.4,0.5,0.6),3,3)P
#The following lines define the Policy for switching between each plane of the 3-
Dimensional matrix, as well as the initial state and the number of iterations. The function is
then ran with these parameters:
Policy <- c(0.4, 0.5, 0.1)
x1 <- 2
n <- 52
run1 <- MC.sim(n,P,x1,Policy)
#The following lines plot a sample path and histogram for the different states of drinking
over the course of one year, two years, and ten years, appropriately updating and re-
running the code with the change in number of iterations:
plot(run1, type = "b", pch = 19, main = "Sample Path of Markov Chain with Actions (1 year)",
     xlab = "Time", ylab = "State")
X11();
hist(run1, col = "Wheat", main = "Histogram of Markov Chain with Actions (1 year)", xlab =
"State")
X11();
n <- 52*2
run2 <- MC.sim(n,P,x1,Policy)
plot(run2, type = "b", pch = 19, main = "Sample Path of Markov Chain with Actions (2 years)",
     xlab = "Time", ylab = "State")
X11();
hist(run2, col = "aquamarine3", main = "Histogram of Markov Chain with Actions (2
```

```
years)",xlab = "State")
X11();
n <- 52*10
run3 <- MC.sim(n,P,x1,Policy)
plot(run3, type = "b", pch = 19, main = "Sample Path of Markov Chain with Actions (10 years)",
    xlab = "Time", ylab = "State")
X11();
hist(run3, col = "tomato", main = "Histogram of Markov Chain with Actions (10 years)", xlab
="State")
```

ACKNOWLEDGEMENTS

Undergraduate Research

NSURJ would like to acknowledge the Undergraduate Research Department for providing admirable opportunities for students to conduct research as undergraduates. Without the NURA, PREP, and Community-based award programs, NSURJ would not have been able to connect with as many intellectually bright undergraduate researchers.

The Undergraduate Research department provides many opportunities for students to grow professionally and financially from doing research at the University of Nevada, Reno. Students and faculty are in great benefit from having a program like this.

Undergraduate Research has always supported NSURJ in our mission to provide students the opportunity to professionally grow while showcasing their superb education.

Wolf Pack Discoveries

NSURJ would like to extend our gratitude to the premier undergraduate research symposium, held at the University of Nevada, Reno. Wolf Pack Discoveries helps early researchers gain experience presenting their research. This event supports the undergraduate academic community in the Nevada Higher Education System and supports the growth of research in an undergraduate system.

Thank you to all who host the event and to the event for providing the opportunity for NSURJ to connect with young researchers.

Associated Students of the University of Nevada (ASUN)

NSURJ would like to extend thanks towards the Associated Students of the University of Nevada (ASUN) for providing support towards the journal's first publication, as well as continuing publications such as this one. ASUN's continued support has allowed NSURJ to grow into the academic stepping stone it is, and has continually made it possible for NSURJ to continue its mission.

ASUN provides needed support for the journal to grow into an outlet for academic development and success for undergraduate researchers to partake in.