

Glutathione use in multiple sclerosis and student's opinion

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Abstract

Objective: To determine pharmacy students' opinions on the role of glutathione and other dietary supplements for the treatment of chronic diseases including Multiple Sclerosis (MS).

Methods: Pharmacy students were asked to complete an online survey to assess their opinions on the role of dietary supplements and glutathione's role in MS using Likert-scale type questions.

Results: A total of forty-two pharmacy students participated in the study with a 100% response rate. Majority of the participants were between the ages of 24- 26 ($n=17$, 40.5%) consisting of mostly females that obtained a bachelor's degree prior to attending pharmacy school. Over half of the students located within the DMV, working full time ($n=21$, 50%) in a pharmacy-related career ($n=16$, 38%), and earning an annual income of less than \$10,000 ($n=13$, 31.0%). Most of the participants said they have adequate knowledge on the use the most common dietary supplements ($n=25$, 60%). A large portion of the participants claimed that they were either had taken dietary supplements in the past ($n=29$; 69%) or were currently on dietary supplements ($n=21$, 50%). When asked specifically about glutathione, over sixty percent ($n=27$; 64%) of them believed in its beneficial health effects in patients with MS; although they did not agree to taking or recommending the supplement but rather consuming glutathione-rich foods since it is a naturally produced hormone. Participants' job type, work experience, and years worked were significantly associated with whether they agreed to take supplements in the past. Variables such as age, job type, years worked, and current working status are also significant factors that determined whether students believed in eating glutathione-rich foods like broccoli and cauliflower instead of taking glutathione supplements. Those that were older in age and had a longer years of work experience were incredulous about taking supplements unless an individual had a poor dietary habit. Other factors such as level of education, gender, or income had no impact on the outcomes.

Conclusion: Our results indicate that first-year pharmacy students believe in the beneficial effects of dietary supplements including the use of glutathione in MS. However, there was a significant finding where individuals who were older, had more work experience and worked in a healthcare setting including a pharmacy-related field had more hesitancy in taking supplements and had a belief that eating a balanced diet or glutathione-rich food was more beneficial than taking the supplements. Therefore, although the participants believed in the use of taking dietary supplements, they have a reservation in recommending it as a potential first-line use unless in cases of deficiency secondary to poor dietary habits.

Keywords: Dietary Supplement; Herbal Supplement; Glutathione; Multiple Sclerosis; Pharmacy Students

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1. Introduction

Glutathione is a supplement with many health benefits and mostly found in local pharmacies. It is a tripeptide (cysteine, glycine, and glutamic acid) found in surprisingly high levels—5 millimolar—concentrations in most cells. Due to the high level of metabolic activity that is used to produce glutathione, such a high level underlines its importance (1). As a carrier of an active thiol group in the form of a cysteine residue, it acts as an antioxidant either directly by interacting with reactive oxygen/nitrogen species (ROS and RNS, resp.) and electrophiles or by operating as a cofactor for various enzymes (2). The diverse roles of glutathione in physiology are relevant to a considerable body of evidence; suggesting that glutathione status may be an important biomarker and treatment target in various chronic, age-related diseases. Knowing this, it is still important to obtain a balance of the supplement and to gain an understanding of its antioxidant and redox balance (3). Not obtaining the right redox balance can cause harm rather than treatment in particular disease states. Researchers and clinicians have optimized glutathione levels to develop treatment strategies that will aid in disease prevention and health promotion among patients (3). One such disease glutathione found to be beneficial is Multiple Sclerosis (MS).

MS is a chronic autoimmune inflammatory disease of the central nervous system, leading to neurodegeneration and manifesting as a variety of symptoms (4). There are number of drugs on the market for the treatment of MS including interferon (IFN)- β , glatiramer acetate (GA), teriflunomide, fingolimod (FTY), mitoxantrone, natalizumab, dimethyl fumarate, and alemtuzumab (5). Ongoing treatment is required to maintain the suppression of inflammation and disease activity in MS (6). Other strategies such as stem cell transplantation have been proposed for the treatment of MS (4) however, no proven treatments exist for changing the course of MS (7).

As the need to discover new drugs and approaches for the treatment of MS persists, researchers have investigated dietary and herbal supplements such as glutathione to treat the symptoms of this disease. It is known that glutathione levels are depleted in the brain of MS patients thus using this antioxidant is beneficial in decreasing the effect of neurological and radiological scoring of acute CNS inflammation (5). Due to its central role in the antioxidant process and high sensitivity to cellular redox changes, glutathione is an important indicator of oxidative status in the human brain and constitutes a potentially interesting candidate as a biomarker in MS (8). N-acetylcysteine (NAC), a precursor to glutathione, has also been an experimental treatment option for patients with MS.

In a randomized controlled study involving twenty-four patients either on NAC or standard care for MS; results proved that NAC affected glucose cerebral metabolism which improved cognition and attention in patients with MS (9). Vitamins of interest to people with MS include vitamin D, vitamin B6, and vitamin B12. Studies showed an association between higher levels and increased vitamin D intake with a reduced risk of developing MS. Based on studies, vitamin D plays a role in MS by repairing myelin, a substance in the body that coats and protects nerves that are damaged in MS leading to symptoms of muscle weakness. Another treatment that has been studied in MS is the use of Marijuana. Marijuana contains chemicals known as cannabinoids that act on the central nervous system (CNS) in ways that may reduce some MS symptoms and perhaps slow disease activity (10). Currently, there is no effective clinical indication for applying dietary supplementation as a complementary treatment against MS symptomatology (7).

Glutathione carries excellent health benefits, yet many healthcare professionals are not aware of its importance and its role in the treatment of disease states. Students' perceptions of the antioxidant are very sparse, and most pharmacy students do not know glutathione's place in pharmacotherapy. Only a few surveys have been done to determine the opinion, knowledge, and understanding students have of glutathione let alone its efficacy in the treatment of MS. Therapies such as interferons and immunosuppressants are studied and incorporated into pharmacy school curriculums, however, glutathione is an area that is quickly brushed though it holds great importance in disease states such as cataracts, kwashiorkor, seizures, Alzheimer's disease, cystic fibrosis, sickle cell anemia, cancer, cardiovascular diseases, and diabetes. As uprising pharmacists, understanding over-the-counter supplements such as glutathione can aid in the decrease of disease progression and should be further studied and implemented to impact the health of our patients. In this study, we investigated pharmacy students' opinions on the use of glutathione in MS as well as their viewpoint on the consumption of dietary supplements.

2. Methods

A total of forty-two pharmacy students at Howard University were enrolled in this study. All of the students submitted responses to the survey with a 100% response rate. The survey was optional and was dispersed amongst the participants in their drug information course to complete. Qualtrics survey platform was used to disseminate the questions as well as to analyze the demographics and responses to the questions. The survey questions consisted of

nine demographic questions, four general lifestyle opinion questions, and five opinion questions on glutathione and its role in MS. The opinion questions were answered using a Likert scale from strongly agree to strongly disagree. The demographic information that was gathered from the participants included gender, age, highest education attended, residence, work experience, type of job worked, annual income, years worked, and lastly current working status. The results obtained from this study were inputted into IBM statistical package for the social sciences (SPSS) for statistical analysis using multiple linear regression, cross-tabulations, and correlation analysis yielding a p-value of less than 0.05 as significant.

3. Results

Tables 1 and 2 highlight the demographics of the participants. The participants' ages ranged from 21 to over 29 years, with most of them being between the ages of 24-26 (n=17; 40.5%). Majority of the participants were females (n=27; 64.3%) and have at least bachelor's degree (n=34; 81%) before enrolling in the pharmacy program.

Table 1 Demographics of Participants n=42

Demographic	Group	N (%)	Mean (Std. Deviation)
Gender	Male	15(35.7)	1.64(0.485)
	Female	27(64.3)	
Age	18-20	0(0)	3.07(1.022)
	21-23	14(33.3)	
	24-26	17(40.5)	
	27-29	5(11.9)	
	>29	6(14.3)	
Highest Education Attended	Some College	1(2.4)	3.12(0.633)
	Associate Degree	1(2.4)	
	BA/BSC	34(81.0)	
	MSC/MA	4(9.5)	
	PhD/Professional	2(4.8)	

As shown in Table 2 over half of the students were located within the D.C., Maryland, and Virginia (DMV) area (n=24; 57.2%). When asked about their work experience, majority of them said they have work experience. Half of them were working full time (n=21; 50%), about one-third, part-time (n=16; 38.1%), and only a small portion of the participants stated that they had no work experience. Within these work experiences that the participants stated, most of them had a job that was pharmacy-related (n=16; 38%) and less than a third of the participants were employed within other healthcare sectors (n=12; 28.57%). The rest of them (n=13; 30.95%) were employed within a non-healthcare career with (n=1; 2%) being non-applicable.

Most of the participants indicated making an annual income of less than \$10,000 (n=13; 31.0%) with a greater portion of the individuals earned an annual income of more than \$40,000 (n=11; 26.2%). The participants included in the study had a wide range of years of work experiences. A larger portion of the participants in the study had worked for 2 years or less (n=19; 45%). When asked about their current working status, only a small portion stated that they are currently working while attending the pharmacy program (n=9; 21.4%).

Table 2 Demographics of participants N=42

Demographic	Group	N (%)	Mean (Std. Deviation)
Residence	Washington D.C	4(9.5)	2.93(1.068)
	Maryland	13(31.0)	
	Virginia	7(16.7)	
	Other States	18(42.9)	
	International	0(0)	
Work Exp	Never worked	2(4.76)	3.33(0.816)
	Short term	3(7.14)	
	Part-time	16(38.10)	
	Full-time	21(50.00)	
Type of job worked	RX-related	16(38.10)	1.98(0.897)
	Other healthcare	12(28.57)	
	Non healthcare	13(30.95)	
	Not Applicable	1(2.38)	
Annual Income	<\$10,000	13(31.0)	2.86(1.617)
	\$10,001-\$20,000	7(16.7)	
	\$20,001-\$30,000	6(14.3)	
	\$30,001-\$40,000	5(11.9)	
	>\$40,000	11(26.2)	
Years Worked	Never Worked	1(2.4)	2.76(0.878)
	1-2 Years	19(45.2)	
	3-4 Years	11(26.2)	
	>4 years	11(26.2)	
Currently working	Yes	9(21.4)	2.14(0.751)
	No, but plan soon	18(42.9)	
	No, no plan working	15(35.7)	

As shown in Table 3, most of the study participants strongly agreed or agreed to having dietary knowledge, taking dietary supplements in the past, or currently taking dietary supplements. However, only a small number of the study participants (n=14, 33%) stated that they engaged in counseling patients on matters related to dietary supplements at their workplace.

Table 3 General Opinion survey questions answered by participants

Descriptive Statistic	Strongly Agree/ Agree	Strongly Disagree/Disagree	Mean (Std Deviation)
Dietary Knowledge	25 (60%)	17 (40%)	2.38(0.70)
Involved in counselling patients	14 (33%)	28 (64%)	2.76(0.88)
Took Dietary supplements	29 (69%)	13 (31%)	2.14(0.87)
Currently on dietary supplements	21 (50%)	21 (50%)	2.43(0.99)

The opinion questions and the responses from the participants are listed below (Table 4). Study participants mostly agreed with the opinion statements, with most students (n=27; 64%) agreeing with the beneficial effects of glutathione. However, the participants had a strong belief in consuming glutathione-rich foods instead of taking supplements (n=31, 74%) unless the person had a risk of deficiency due to poor dietary habits (n=30, 71%).

Table 4 Opinion questions on Glutathione answered by participants

Descriptive Statistics	Strongly Agree/ Agree	Strongly Disagree/ Disagree	Mean (STD)
Statement 1: I believe in the use of glutathione which also has additional benefits by having amino acids in using to manage MS	27(64%)	15(36%)	2.19(0.83)
Statement 2: I do not believe in the use of supplements such as glutathione that can already be made by the body to be used for the treatment of patients with MS	23(55%)	19(45%)	2.45(0.86)
Statement 3: I believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione supplement	31(74%)	11(26%)	2.02(0.90)
Statement 4: I may consider recommending a glutathione supplement to a patient who does not eat glutathione rich foods and is bodily deficient to manage MS	30(71%)	12(29%)	2.07(0.78)
Statement 5: Glutathione is one of the natural substances produced in the body and I feel comfortable in recommending it to patients with MS	28(67%)	14(34%)	2.19(0.86)

Table 5 shows that demographic variables such as work experience, job type, and years worked in association with opinion-based survey responses were significant ($p < 0.05$). These demographic factors were significant contributors to determining whether a participant had taken dietary supplements in the past or were currently on dietary supplements including vitamins.

Table 5 Significant demographic associations with general opinion questions

Variable Association	P-Values
Work Exp vs agree to take dietary supplements in the past	0.029
Job Type vs agree to take dietary supplements in the past	0.023
Job type vs currently on dietary supplements including vitamins	0.024
Years worked vs agreeing to take dietary supplements in the past	0.012

The following table (Table 6) shows the impact of work experience as a factor for participants taking a dietary supplement. Those who had a full-time job (n=18; 42.8%) strongly agreed/agreed more to taking dietary supplements

comparing to their counterparts. However, more than half of the study participants who at least had a part-time job (n=9; 21.4%) also strongly agreed/agreed to taking dietary supplements in the past. These results were significant with a p-value of 0.029. Job type was also an influential factor to determine whether study participants took supplements in the past or were currently on dietary supplements.

Table 6 Amount of Work Experience in association with taking dietary supplements in the past

Work Experience (p-value - 0.029)						
Took Dietary Supplements		Never Worked	Short Term	Part Time	Full time	Total
Strongly Agree/ Agree	Count (% of total)	1 (2.4%)	1 (2.4%)	9 (21.4%)	18 (42.8)	29 (69%)
Strongly Disagree/Disagree	Count (% of total)	1 (2.4%)	2 (4.8%)	7 (16.7%)	3 (7.1%)	13 (31%)
Total		2 (4.8%)	3 (7.2%)	16 (38.1)	21 (49.9%)	42 (100%)

In Table 7, study participants with pharmacy-related jobs (n=12; 28.6%) and other healthcare jobs (n=10; 23.8%) strongly agreed/agreed to taking dietary supplements in the past compared to study participants with non-healthcare job types with a p-value of 0.023. Additionally, a majority of the study participants who were employed in any field (n=29; 69.1%) strongly agreed/agreed to taking dietary supplements in the past.

Table 7 Job type in association with taking dietary supplements in the past

Job Type (p-value = 0.023)						
Took Dietary Supplements in the past		RX-Related	Other Health care	Non-Health Care	Not Applicable	Total
Strongly Agree/ Agree	Count (% of total)	12 (28.6%)	10 (23.8%)	7 (16.7%)	0 (0.0%)	29 (69.1%)
Strongly Disagree/ Disagree	Count (% of total)	4 (9.5%)	2 (4.8%)	6 (14.2%)	1 (2.4%)	13 (30.9%)
Total		16 (38.1%)	12 (28.6%)	13 (30.9%)	1 (2.4%)	42 (100%)

Table 8 shows the investigation of job type in association with the current use of dietary supplements including vitamins which was significant with a p-value of 0.024. More than half of study participants with pharmacy-related, health care, and non-healthcare job types (n=28; 66.7%) strongly agreed/agreed to the current use of dietary supplements or vitamins.

Table 8 Job type in association with the current use of some type of dietary supplement including vitamins

Job Type (p-value = 0.024)						
Currently on some type of dietary supplement including vitamins		RX-Related	Other Health care	Non-Health Care	Not Applicable	Total
Strongly Agree/ Agree	Count (% of total)	9 (21.4%)	9 (21.4%)	10 (23.8%)	0 (0.0%)	28 (66.7%)
Strongly Disagree/ Disagree	Count (% of total)	7 (16.7%)	3 (7.1%)	3 (7.1%)	1 (2.4%)	14 (33.3%)
Total		16 (38.1%)	12 (28.6%)	13 (31.0%)	1 (2.4%)	42 (100%)

As demonstrated in Table 9, the length of years worked also influenced whether study participants had taken dietary supplements in the past with a p-value of 0.012. Study participants who had less work experience of 1-2 years (n=10, 23%) strongly disagreed/disagreed with taking dietary supplements in the past while all individuals that had worked more than 4 years (n=11, 26.2%) strongly agreed/agreed with the statement.

Table 9 Years worked in association with taking dietary supplements in the past

Years Worked (<i>p-value = 0.012</i>)						
Took Dietary supplement in the past		Never Worked	1-2 Years	3-4 Years	>4 Years	Total
Strongly Agree/ Agree	Count (% of total)	0 (0.0%)	9 (21.4%)	9 (21.4%)	11 (26.2%)	29 (69%)
Strongly Disagree/Disagree	Count (% of total)	1 (2.4%)	10 (23.8%)	2 (4.8%)	0 (0.0%)	13 (31%)
Total		1 (2.4%)	19 (45.2%)	11 (26.2%)	11 (26.2%)	42 (100%)

Table 10 showed that the demographic variables age, job types, years worked, and working now status in association with whether study participants agreed to statement 3 were significant with *p*-values of less than 0.05.

Table 10 Demographic variables in association with an opinion on glutathione survey responses

Variable Association	<i>p-values</i>
Age vs. agreeing to believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione supplement	.005
Job type vs. agreeing to believe in eating glutathione rich foods like broccoli and cauliflower instead of taking glutathione	0.012
Years worked vs agreeing to believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione	0.013
Working now vs agreeing to believe in eating glutathione rich foods like broccoli and cauliflower instead of taking glutathione	.009

In Table 11, study participants aged 21-26 (*n*=24; 57.2%) agreed more to statement 3 than students' participants 27 or older. A majority of the student participants from 21 to older than 29 (*n*=31; 73.8%) strongly agreed/agreed to statement 3 with a *p*-value of 0.005.

Table 11 Age in association with belief in eating glutathione rich foods instead of taking a glutathione supplement

Age in years (<i>p-value=.005</i>)						
Statement 3: I believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione supplement		21-23	24-26	27-29	>29	Total
Strongly Agree/Agree	Count (% of total)	13 (31.0%)	11 (26.2%)	3 (7.1%)	4 (9.5%)	31 (73.8%)
Strongly Disagree/ Disagree	Count (% of total)	1 (2.4%)	6 (14.3%)	2 (4.8%)	2 (4.8%)	11 (26.2%)
Total		14 (33.3%)	17 (40.5%)	5 (11.9%)	6 (14.3%)	42 (100%)

It can be seen in Table 12 that job type had an association with whether students strongly agreed/agreed to statement 3 with a *p*-value of 0.012. When asked if study participants agreed with statement 3, study participants with a non-healthcare background (*n*=12; 28.6) agreed the most compared to the other job types. Most study participants that were employed (*n*=31;73.8%) agreed to statement 3 regardless of if they had a healthcare-related job type.

Table 12 Job type in association with belief in eating glutathione-rich foods instead of taking glutathione supplements

Job Type (<i>p-value=0.012</i>)

Statement 3: I believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione supplement		RX-Related	Other Healthcare	Non-Health Care	Not Applicable	Total
Strongly Agree/Agree	Count (% of total)	9 (21.4%)	9 (21.4%)	12 (28.6%)	1 (2.4%)	31 (73.8%)
Strongly Disagree/Disagree	Count (% of total)	7 (16.7%)	3 (7.1%)	1 (2.4%)	0 (0.0%)	11 (26.2%)
Total		16 (38.1%)	12 (28.6%)	13 (31%)	1 (2.4%)	42 (100%)

In Table 13, student participants that had 1-2 years of working experience (n=15; 35.7%) agreed more with statement 3 compared to study participants that never worked or had more than 2 years of experience which yielded a p-value of 0.013.

Table 13 Years worked in association with the belief in eating glutathione rich foods instead of taking a glutathione supplement

Years Worked (<i>p-value=0.013</i>)						
Statement 3: I believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione supplement		Never Worked	1-2 Years	3-4 Years	>4 Years	Total
Strongly Agree/Agree	Count (% of total)	1 (2.4%)	15 (35.7%)	7 (16.7%)	8 (19.1%)	31 (73.8%)
Strongly Disagree/Disagree	Count (% of total)	0 (0.0%)	4 (9.5%)	4 (9.5%)	3 (7.1%)	11 (26.2%)
Total		1 (2.4%)	19 (45.2%)	11 (26.2%)	11 (26.2%)	42 (100%)

Table 14 showed that working status in association with statement 3 was significant with a p-value of 0.009. The study participants that were currently not working and did not plan to work soon (n=14; 33.3%) mostly agreed to statement 3.

Table 14 Working status in association with belief in eating glutathione rich foods instead of taking glutathione supplements

Working Status (<i>p-value= 0.009</i>)					
Statement 3: I believe in eating glutathione rich foods like broccoli and cauliflower instead of taking a glutathione supplement		Yes	No, but plan soon	No, no plan working	Total
Strongly Agree/Agree	Count (% of total)	6 (14.3%)	11 (26.2%)	14 (33.3%)	31 (73.8%)
Strongly Disagree/Disagree	Count (% of total)	3 (7.1%)	7 (16.7%)	1 (2.4%)	11 (26.2%)
Total		9 (21.4%)	18 (42.9%)	15 (35.7%)	42 (100%)

4. Discussion

The goal of this study was to determine pharmacy students' opinions on the role of glutathione and other dietary supplements for the treatment of chronic diseases including Multiple Sclerosis (MS). A total of 42 pharmacy students surveyed in this study. Our results indicate that participants believe in the beneficial effects of glutathione. However, they have a reservation in recommending it as a potential first-line use in the treatment of MS unless in cases of deficiency secondary to poor dietary habits.

The use of supplements within our society has increased due to the belief that with a healthy diet in conjunction with supplements; there is an increase in overall well-being with little to no risk. In a study performed at Howard University on the opinions of Pharmacy students' perception of herbal supplements, most of the first-year students (n=44, 88.7%) agreed that there is not enough medical research to support the quality of herbal and dietary supplements (11). The

study concluded that the lack of research on these supplements limited the idea of recommending them to patients and substituting them with their prescription drugs. In another study, almost a majority (n=355; 47.3%) of pharmacy students agreed to the use of dietary supplements to treat health problems, however, they lacked knowledge regarding the health benefits of certain supplements such as glucosamine and St. John's Wort (12). We can confidently say that there is a gap in knowledge amongst pharmacy students and their outlook on the health benefits of herbal and dietary supplements in disease states.

In this study, the majority of participants (n=25; 60%) claimed they were knowledgeable on dietary supplements or had taken dietary supplements in the past. However, they had limited experience or involvement in counseling patients although a majority of them were employed in a pharmacy-related field (n=16; 38%) as shown in Table 3. It was not specified which sector of pharmacy-related careers the students were employed in and the reason for the lapse; however, it may be due to students being employed in a hospital pharmacy setting where there is little to no patient interaction or opportunity for counseling.

Majority of the student participants (n=27; 64.3%) agreed that glutathione is beneficial in the management of MS although, over half of the participants (n=23; 55%) did not believe in using glutathione in the management of MS, since it is naturally produced by the body. Over three-thirds of the student participants (n=31; 74%) agreed to eating glutathione-rich foods such as broccoli and cauliflower as a better alternative to taking supplement. This may be due to the lack of FDA approval of these supplements minimizing the confidence and recommendation of its use.

On the other hand, over one-half of the participants (n=30; 71%) agreed that they consider recommending a glutathione supplement to a patient with a poor dietary habit or are deficient. That means, students agreed to recommend only after a seen deficiency in the supplement and in patients that were not able to consume glutathione-rich foods. This finding continues to support the belief that glutathione supplement is viewed as a last resort in treatment although there is some benefit for individuals with MS.

Most of the participants that were employed full time (n=18; 42.8%), had taken dietary supplements as well as individuals that worked in a pharmacy-related field (n=12; 28.6%). Most of the individuals who did not take dietary supplements worked either part-time or never employed in a healthcare-related settings which was expected being that the individuals may have had a lack of knowledge of dietary supplements and the implications of MS due to prior non-exposure. The findings were consistent with the increased knowledge and exposure of dietary supplements aiding in individuals taking supplements to benefit their health or aid in lack of essential vitamins.

There was a significant correlation ($p=0.012$) between those with a long employment history of more than four years and shorter employment history in taking dietary supplements in the past. There was a marked negative correlation between the number of years worked and whether those individuals took dietary supplements. The correlation revealed that the more years an individual worked, the less that individual agreed to take a dietary supplement in the past. This finding may be due to individuals that have been employed longer, having more knowledge and understanding of the use of supplements/vitamins, more life experiences, and can also be attributed to the lack of evidence surrounding its use in particular disease states compared to individuals who have never worked or have worked fewer years.

When the opinion statements about glutathione and MS were analyzed, significance was found regarding the age, job type, years worked, and current work status of the participants and agreeing to eat glutathione-rich foods like broccoli and cauliflower instead of taking a glutathione supplement. The associations were broken down further into correlations in tables 11-14 to determine whether there was a positive or negative relationship between the variables.

Although most of the participants (n=31; 73.8%) agreed to eating glutathione-rich foods instead of taking supplements, there was a positive correlation between age and the belief in eating glutathione-rich foods instead of taking supplements. As the ages of the participants increased, more individuals believed in eating glutathione-rich foods. This is coherent with the finding that an increase in age, which is associated with more life experiences, comes with less desire to take dietary supplements but rather obtain nutrients from food sources.

Although most individuals employed within a pharmacy-related field (n=9, 21.4%) agreed to eating glutathione-rich foods, the gap in percentage was close indicating that pharmacy students are still hesitant about the consumption of supplements and vitamins, specifically glutathione, regardless of whether they work in a healthcare setting or not. Individuals that were not employed in healthcare had the highest agreeable rate of consuming glutathione-rich foods instead of the supplement. This may be due to the possibility they are not as well versed or do not have vast exposure to dietary supplements, especially glutathione to know its benefits and contributions to health. The findings were

consistent, seen throughout the study, that although not all the students had been exposed to a healthcare background, they believed that eating glutathione-rich foods came first before consuming glutathione supplements.

It is seen that more hesitancy in the consumption of glutathione increases with age and more work experience. There is a direct correlation between the number of years a student worked and his or her opinion in believing consuming glutathione-rich foods instead of taking glutathione supplements. A positive correlation was seen whereby with more work experience, individuals are more likely to eat glutathione-rich foods instead of taking supplements specifically glutathione.

Overall, there was a significant finding where individuals who were older, had more work experience and worked in a healthcare setting including a pharmacy-related field had more hesitancy in taking supplements and had a belief that eating glutathione-rich foods was more beneficial than taking the supplements. The pharmacy students, based on the findings, would recommend not glutathione to patients with MS with the current dietary knowledge they withhold unless laboratory findings showed marked deficiency.

Age, place of residence, and annual income were seen to have a wide range of variety having a skewed standard deviation. It should be noted that some of the results that were obtained within this study did not yield any statistical significance in association with pharmacy students' general opinion on dietary supplements/vitamins as well as their opinion of the use of glutathione in MS. The demographics and associations that were not significant include the gender, highest education attended, residence, annual income, experience in counseling patients, and dietary knowledge.

There were various limitations to this study. The most impactful limitation of this study was the limited sample size and the students being from only one pharmacy school. A larger sample size that includes of multiple pharmacy schools would have yielded more reliable and generalized results. Another limitation is the surveying of only 1st-year pharmacy students were surveyed which may not be as impactful due to limited knowledge regarding the various chronic diseases including multiple sclerosis.

5. Conclusion

In this survey study, the opinions of uprising medication experts were analyzed and evaluated on the use of dietary supplements and vitamins, specifically glutathione, and its benefits. Many of the students agreed to have dietary knowledge however most of them did not value the importance of glutathione and believed there were better alternatives to receiving glutathione in the body as opposed to taking the supplement. The students also believed that glutathione is essential. However, they do not see its potential as a prominent first-line treatment in MS unless an individual is deficient because of poor dietary habits or other chronic illness. This opens a discussion about whether herbal and dietary supplements should be given the same emphasis in the pharmacy curriculum as prescription medications just to increase the knowledge and opinions of supplements.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

Statement of informed consent

Not applicable since this is done as a part of a course that is mandatory in our College.

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