



(RESEARCH ARTICLE)



Pharmacy students' knowledge in the use of glutathione for multiple sclerosis

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Abstract

Objective: To determine first-year pharmacy students' knowledge of the role of dietary and herbal supplements such as glutathione (GSH) on Multiple Sclerosis (MS).

Methods: Forty-two first-year pharmacy students were asked to complete an online survey to assess their knowledge of the use of GSH in the treatment of MS using Likert-scale type questions.

Results: Participants were given an optional survey which received a 100% response. The majority of the participants were between the ages of 24 and 26 (n=17, 40.5%), females (n=27, 64.3%); located in the DMV area and had a BA/BSC degree (n=34, 81%) before joining the pharmacy program. The majority of the participants had a full-time job (n=21, 50%) with over one-third with pharmacy-related jobs (n=16, 38.10%) and an annual income of <\$10,000 (n=13, 31.0%). The student participants were asked five knowledge questions to analyze their knowledge of the use of GSH. The five knowledge questions were 1. Use of GSH to prevent MS-induced damage; 2. Free radicals as causes of MS; 3. GSH release in MS; 4. The beneficial effect of GSH in MS; and 5. Limitation of GSH in MS. A passing score of 75% or higher was achieved in only a small percentage of student participants (n=14; 33.3%). When asked the knowledge questions, more than seventy percent (70%) of student participants answered at least one of the questions incorrectly with an overall average knowledge score of 56.7%. Question #2 answered by most of them yielding a percentage of 76.2%. Student participants age 24-26 (n=15, 26.2%) significantly agreed to the same question (p -value = 0.007). A small amount of the study participants (n=13; 31.06%) who worked for 1-2 years also significantly agreed to question #3 (p = 0.010). More than half of the participants between 21 to more than 29 years old and who had worked at least 1-2 years agreed to question #2.

Conclusion: Our results indicate that first-year pharmacy students have limited knowledge on the use of glutathione in the treatment of MS. On the knowledge questions, only a small number of participants received a passing score of 75% or higher. The average score was 56.7%. This signifies that there are many areas for improvement. The use of GSH is expanding its use from a dietary supplement to possible treatment of disease states such as MS. Students may have limited knowledge on the use of GSH may be due to lack of exposure in the pharmacy curriculum as first-year professional students.

Keywords: Glutathione; Dietary Supplements; Knowledge; Multiple Sclerosis

1. Introduction

Glutathione (GSH) is a dietary supplement that has been used for its many health benefits. High concentrations of GSH are produced in the liver making it critical in the body's detoxification process (1). GSH is involved in many body processes including tissue building and repair, making proteins and chemicals necessary for the body and the immune

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system function (2). Due to GSH being endogenously synthesized throughout the body and found in most cells, it is one of the most studied antioxidants (3). As an antioxidant, it acts as a scavenger of electrophilic and oxidative species directly or through enzymatic catalysis (4). The use of GSH can help to reduce oxidative stress which occurs when there is an imbalance between the production of free radicals and the body's ability to battle them off. High levels of oxidative stress can be associated with multiple disease states such as diabetes, cancer, and rheumatoid arthritis. GSH can prevent diseases by regulating oxidative stress levels (5). The development of free radicals and oxidative stress during exercise is an important consideration for optimal performance, recovery, and health (3). GSH is approved by the Food and Drug Administration (FDA) for the prevention of nerve damage and toxicities from cisplatin. There is interest in using GSH to treat many other disease states including MS (2). Federal regulations require evidence that each substance is safe at its intended level of use before it is approved. In this study, we focused on the possible use of GSH.

MS is a potentially disabling disease of the brain and spinal cord with the immune system attacks the protective sheath (myelin) causing permanent damage or deterioration of the nerves. Signs and symptoms of MS vary widely and depend on the amount of nerve damage and which nerves are affected. Some people with severe MS may lose the ability to walk independently or at all, while others may experience long periods of remission without any new symptoms (3). In the past, immunosuppressants have been the choice of treatment such as natalizumab, or ocrelizumab besides others (6). The common conventional therapy for MS contains certain immune-modulating drugs to reduce the relapse frequency, glucocorticoids for the treatment of acute exacerbations, and amantadine for fatigue treatment. There are also several other medications for more specific MS-related symptoms. The effects of these treatments are partially for symptomatic alleviation and do not stop the ongoing neurodegeneration⁸.

Vitamins such as vitamin D, antioxidant vitamins, vitamin B6, and vitamin B12 are of interest. Marijuana may also claim to reduce some MS symptoms and perhaps slow disease activity (7-8). N-acetylcysteine (NAC) has also been a treatment option for patients with MS (9). However, currently, there is no effective clinical indication for applying dietary supplementation as a complementary treatment against MS symptomatology (7). GSH is one dietary supplement that is in consideration.

GSH besides MS carries various health benefits but yet there are only little to no surveys have been done to determine the knowledge and understanding that students in the use of GSH in its efficacy in the treatment of MS. Therapies such as interferons and immunosuppressants are studied and incorporated into pharmacy school curriculums however there is a lack of education on GSH despite it plays a key factor in many chronic diseases including MS. As future pharmacists, it is crucial to understand how over-the-counter supplements such as GSH can aid the progression of many diseases.

2. Methods

The survey was prepared and collected during a Drug Informatics course, a mandatory course for the first-year pharmacy students. Forty-two students registered for the class at the time of the survey. All of the 42 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. We use Qualtrics survey platform to disseminate the questions as well as to analyze the demographics and responses to the questions. The survey questions consisted of nine demographic questions and five knowledge questions on glutathione. All the questions were answered using a Likert scale from strongly agree to strongly disagree. Besides the survey questions, demographics such as, age, highest education attended, residence, work experience, type of job worked, annual income, years worked, and lastly current working status were also collected. 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 tabs, and correlation analysis yielding a p-value of less than 0.05% as significant.

3. Results

A total of 42 second-year pharmacy students from Howard University College of Pharmacy were surveyed and answered the five prompted survey questions with a 100% response rate. Table 1 and 2 illustrates the demographic data of the participants of the study. The individuals' ages that participated in this study ranged from 21 to over 29 years of age, with a majority of the students being between the ages of 24-and 26 (n= 17, 40.5%). The study included twice as many females as males. A greater percentage of the participants were of the female gender (n=27, 64.3%). The pool of study participants consisted of a variety of education levels. A vast majority of the participants (n=34, 81.0%) had completed a Bachelor of Arts or Science degree before attending pharmacy school. A multitude of the student participants (n=18,42.9%) resided in other states other than Washington, D.C, Maryland, and Virginia.

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)	

Half of the study participants (n=21, 50%) work full-time while the other half (n=21, 50%) work part-time, work short-term, or never worked. However, the types of jobs varied with (n=16, 38%) being pharmacy-related, (n=13, 31%) non-healthcare related, (n=11, 29%) other healthcare professions, and 2% non-applicable. Less than half (n=13, 31%) of the study participants earn less than \$10,000 with the remainder (n=11, 26%) earn more than \$40,000. The participants included in the study had a variety of years worked. Almost half of the study participants (n=19, 45%) worked for 1-2 years and the majority of the study participants (n=22, 52.4%) worked 3-4 years or more than 4 years. The majority of the study participants (n=18, 43%) are not currently working but plan to work soon. The rest of the study participants (n=15, 36%) of the study participants are not currently working and do not plan to.

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)	

The results from this study showed that students have limited knowledge about the use of GSH (Table 3). The scores of the study participants based on the five knowledge questions various from lowest 45.2% to highest 71.4%. Only a small amount of the study participants (n=14, 33.3%) received a score that was above the passing score of 70%. The question that received the lowest score was question #5 that states GSH is only used as an antioxidant in MS patients and has no other effects. Only three questions (question #1, 2 & 3) received a passing score above 70%. The question that states the cause of MS as free radicals received the highest score. The overall correct score was much lower than expected (57%).

Table 3 Percentage of correctness amongst participants based on answering knowledge questions

Question	Correct answers (T/F)	% of students that answered correctly (N=42)	%of students that answered incorrectly (N=42)
1. Glutathione can prevent damage to important cellular components caused by reactive oxygen species in patients with MS	True	71.4%	28.6%
2. Free radicals, peroxides, lipid peroxides, and heavy metals are all considered reactive oxygen species that contribute to the development of MS	True	76.2%	23.8%
3. Glutathione is released in the presence of stress which may worsen signs and symptoms of MS	False	28.6%	71.4%
4. Deregulation of Glutathione homeostasis can alter neural activity if given to patients with MS	True	64.3%	35.7%
5. Glutathione is only used as an antioxidant in MS patients and has no other effects	False	54.8%	45.2%

Number of Participants (%)	Score
14/42(33.3%)	Scored 80% (above average)
14/42 (33.3%)	Score 60% (below average)
7/42 (16.7%)	Scored 40% (below average)
7/42 (16.7%)	Scored 20% (below average)
Average Score	56.7% (Passing >70%)

Question Answered Correctly the most	Q#2: Free radicals, peroxides, lipid peroxides and heavy metals are all considered as reactive oxygen species that contribute to the development of MS
Question Answered Correctly the least	Q3#: Glutathione is released in the presence of stress which may worsen signs and symptoms of MS

When investigating age and years worked on whether student participants agreed to question #2 (Free radicals as causes of MS) the results were significant with age (p-value = 0.007) and years worked (p-value = 0.010) as seen in Table 4.

Table 4 Demographic variables in association with knowledge-based survey responses

Variable Association	p-values
Age vs. agreeing to Free radicals, peroxides, lipid peroxides and heavy metals are all considered as reactive oxygen species that contribute to the development of MS	0.007
Years worked vs. agreeing to Free radicals, peroxides, lipid peroxides and heavy metals are all considered as reactive oxygen species that contribute to the development of MS	0.010

The following table shows the survey question response in association with age. The student participants age 24-26 (n=15, 26.2%) mostly strongly agreed/agreed to question #2.

Table 5 Survey question response in association with age

		Age				
Free radicals, peroxides, lipid peroxides and heavy metals are all considered as reactive oxygen species that contribute to the development of MS		21-23	24-26	27-29	>29	Total
Strongly Agree/ Agree	Count (% of total)	9 (31.0%)	15 (26.2%)	3 (7.1%)	5 (11.9%)	32 (76.2%)
Strongly Disagree/Disagree	Count (% of total)	5 (2.4%)	2 (14.3%)	2 (4.8%)	1 (2.4%)	10 (23.8%)
Total		14 (33.3%)	17 (40.5%)	5(11.9%)	6 (14.3%)	42 (100%)

P-value=0.007 → negative correlation; The older the student participants, the less they agree to this question

Table 6 shows the survey question response in association with years worked. A small amount of the study participants (n=13, 31.06%) who worked for 1-2 years strongly agree/agreed to question #3.

Table 6 Survey question response in association with years worked

		Years Worked				
Free radicals, peroxides, lipid peroxides and heavy metals are all considered as reactive oxygen species that contribute to the development of MS		Never Worked	1-2 Years	3-4 Years	>4 Years	Total
Strongly Agree/Agree	Count (% of total)	0 (0.0%)	13 (31.0%)	9 (21.4%)	10 (23.8%)	31 (73.8%)
Strongly Disagree/Disagree	Count (% of total)	1 (0.0%)	6 (14.2%)	2 (4.8%)	1 (2.4%)	11 (26.2%)
Total		1 (2.4%)	19 (45.2%)	11 (26.2%)	11 (26.2%)	42 (100%)

P-value = 0.010 → Negative correlation: The more years worked, the less they agreed to this statement

4. Discussion

GSH is marketed as a dietary supplement and does not require extensive pre-marketing approval from the FDA therefore it should be used with caution. Injectable GSH is approved in the Philippines as an adjunct treatment in cisplatin chemotherapy and has become popular for skin whitening treatments. GSH is known for its antioxidative effects however it is being used beyond that in its treatment of MS. When considered for the treatment of MS, GSH must be approved by the FDA as a drug since it is indicated to cure the disease and not just as an antioxidant. The goal of this study was to evaluate students' knowledge of the use of GSH. Participants were asked five knowledge questions besides the demographic related questions to determine their knowledge of GSH and its beneficial treatment in MS.

According to the results, the study participants had limited knowledge of the use of GSH which was demonstrated by an average knowledge score of 56.7%. Study participants answered question #2 (Table 3) most correctly yielding a percentage of 76.2%, compared to question #3 in which 71.4% of student participants answered incorrectly. This could be due to the fact that GSH is not a common dietary supplement, so it is not surprising that students do not have much knowledge of its use. MS is also a type of disease state that the study participants may not be knowledgeable about at their level of training in the pharmacy program.

In association with age, (n=32, 76.2%) of the student participants from age 21 to more than 29 agreed with question #2 (p-value = 0.007). The results show that age plays a role in whether students agreed with the statement. There was a negative correlation between age and whether they agree or disagree to question #3. The older the student participants, the less they agreed with this question. GSH has been used as a dietary supplement for a long time and its new indications for treatment may not be known to older student participants.

In association with years worked (n=31, 73.8%), the study participants that had at least 1-2 years of work experience significantly agreed to question #2 (p-value of 0.010). There was a marked negative correlation between years worked and whether student participants agreed to question #2. The more years the study participants worked, the less they agreed to question #2. This could be because student participants may not have been exposed to GSH in their work environment. Student participants must have adequate knowledge of not only medications but also dietary supplements. As medication experts, we must be up to date to effectively provide patients with the relative education to improve their patient outcomes.

Some studies discuss students' awareness of GSH and results indicate that only a few pharmacy students are aware of the use of GSH and its importance. In one study 100 pharmacy undergraduates were asked different questions and a small number of students (n=12, 12%) knew the treatment of GSH deficiency while the remaining (n=88, 88%) students did not know about the treatment of GSH deficiency (10). In another study, 387 university students were accessed using a questionnaire. The knowledge of GSH, GSH consumption, and attitudes toward GSH consumption were at the intermediate level (11). In a third study, clinical medical students were asked to evaluate the cosmetic effectiveness and side effects of GSH (12). The results showed that most (54.7%) of the clinical medical students in one study had insufficient knowledge about GSH to be able to advise patients and most wanted to learn more in class or on the internet. The results from these studies differ from ours because we analyzed students' knowledge of the role of GSH specifically in MS.

Based on the mean and standard deviation of this study, a high variation was obtained (1.022) among age groups (Mean=3.07). The residence and annual income had a skewed standard deviation of 1.068 (mean=2.93) and 1.617 (mean=2.86). There was a low variation in the remainder of the variables which is optimal and more reliable based on the close proximity of the data points to the mean with little to no outliers. Some of the results obtained within this study did not yield any statistical significance (p<0.05) in association with pharmacy students' knowledge of GSH in MS. The demographics and associations that were not significant include gender, highest education attended, residence, type of job worked, annual income, work experience, and currently working.

Limitations to the study include the low number of questions that were to access knowledge. If more questions were asked, students could have performed better bringing the average score possibly to a passing score of 70%. Another limitation could have been the limited sample size collected as well as the study participants selected were all in their first didactic year. Additionally, the curriculum does not include dietary supplements during their first-year curriculum.

5. Conclusion

GSH is an antioxidant that helps balance free radicals. Having too many free radicals can cause damage at the cellular level, which is how many diseases start. GSH is an important indicator of oxidative stress in the brain and can be an interesting biomarker in MS in preventing the neurodegenerative processes associated with progressive MS. Dietary habits and proper dietary intake of antioxidants in the diet may be one of the most important environmental factors for the prevention of MS. The use of glutathione is still being investigated however if used for the treatment of MS, it must first be approved as a drug. In this study, pharmacy students are found to have a limited knowledge of the use of GSH in the treatment of MS. The average knowledge score is much lower (56.7%) than the expected for passing, 70 percent. Only one-third of the study participants (n=14, 33%) received a passing score of 80%. Age and years worked were significant variables in determining whether students were knowledgeable about GSH in the use of MS (p-values = 0.07 and 0.010 respectively).

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. All author declare that they do not have any conflict of interest.

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