Identifying the Prevalence of Vitamin C Deficiency and Examining the Associated Factors in Children, Adolescents, and Young Adults with Cancer

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Background

- Vitamin C deficiency is estimated to occur in up to 70% of patients with cancer.[1]
- Vitamin C deficiency is associated with lower quality of life and faster progression of disease in patients with cancer.[2,3]
  - It is also correlated with higher infection rates, anemia, bone pain, muscle degeneration, and even delayed wound healing.[4]
- Cancer-related and treatment-related hormone and metabolism disturbances and an overall decreased dietary intake of vitamin C all contribute to the high prevalence of vitamin C deficiency among the cancer patient population.[5]
- Thus far, research on vitamin C deficiency has been conducted almost exclusively in adult populations.
- Vitamin C deficiency has unique and potentially severe consequences in pediatric, adolescent, and young adult (AYA) populations with cancer due to their unique developmental needs[1,6] requiring research focused specifically on children with cancer.

Aims

1. Determine the prevalence of vitamin C deficiency in children/AYAs with cancer.
2. Examine the factors associated with vitamin C deficiency in children/AYAs with cancer.

Methods

Study Design:

- Prospective, cohort study

Patients:

- Pediatric and AYA cancer patients
- Age range: 6 – 39 years old
- Data extracted between 6/28/2019 and 7/30/2023 from Epic

Variables of Interest:

- *Vitamin C Level (**Primary Outcome**)*
  - Not Deficient ($>0.2\ \mu mols/L$)
  - Deficient ($\leq 0.2\ \mu mols/L$)
- *Demographic Factors*
  - Age at diagnosis, sex, race, ethnicity
- *Lifestyle Factors*
  - Average steps per day (Fitbit)
- *Clinical Factors*
  - Vital status
  - Tumor type
  - Surgery, radiation, chemotherapy (yes/no)
  - Number of hospitalizations

Methods

Statistical Methods:

- Descriptive statistical analysis used to describe the cohort's characteristics
- Logistic regression used to determine associations between demographic, lifestyle, clinical characteristics and vitamin C deficiency
- Backward selection was used to determine the final multivariable model

Results

Figure 1. Prevalence of Vitamin C Deficiency

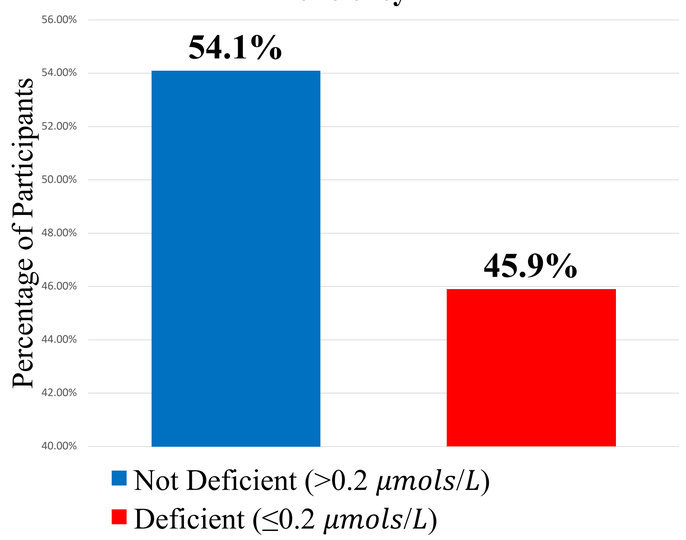

Table 1. Demographics and Variables of Interest (n=108)

Variables	Count (%)
Sex	
Male	64 (59.3%)
Female	44 (40.7%)
Race/Ethnicity	
Non-Hispanic White	56 (52.3%)
African American	15 (14%)
Hispanic	28 (26.2%)
Asian	4 (3.7%)
Other Race	4 (3.7%)
Vital Status as of 7/2023	
Not Expired	79 (73.1%)
Expired	29 (26.9%)
Type of Tumor	
Blood cancers	40 (37.0%)
Non-CNS Tumors	56 (51.9%)
CNS Tumors	12 (11.1%)
Radiation (yes)	(47.2%)
Surgery (yes)	(62.0%)
Chemotherapy (yes)	(97.2%)
	Mean (±SD)
Age at Diagnosis	17.7 (6.2)
Vitamin C (Serum) Level	0.56 (0.32)
Number of Hospitalizations	11.6 (7.9)

Factors associated with Vitamin C deficiency:

• Using only patients with complete data **(n=71)**, we conducted purposeful variable selection for the population based on p value of 0.10 through univariate analysis.

• Univariate analysis showed that sex (p=0.006), surgery (p=0.000), and number of hospitalization (p=0.024) were associated with Vitamin C deficiency.

• Additionally, age at enrollment, average steps per day, type of cancer, surgery (yes/no), and number of hospitalizations met the purposeful variable selection criteria.

Table 2. Results (n=71)

		95% CI for EXP(B)	
Variable	*Exp(B)*	*Lower*	*Upper*
Age on Study	1.1268*	1.007	1.260
Gender (female)	0.088*	0.018	0.422
Surgery (yes)	0.255*	0.069	0.945
Number of Hospitalizations	1.118*	1.023	1.220
Average Steps	1.000	1.000	1.000

*: $p<0.05$

Results

- Multivariable model shows that age at diagnosis, sex, surgery, and number of hospitalizations all contributed significantly to the model.
- Female sex and having had cancer surgery both decrease odds of being deficient
- For every one unit increase in age and number of hospitalizations, odds of deficiency also increase.

Conclusions

- Nearly half of the children and AYAs with cancer in our study were vitamin C deficient, and the mean vitamin C serum level was 0.56 $\mu mols/L$.
  - Between 5-6% of children and adolescents in the US are vitamin C deficient[7] and the mean vitamin C serum level is 0.51 $\mu mols/L$.[5]
- Many of the associated risk factors match what was expected based on current publications.[3]
  - These included male sex and the number of hospitalizations.
  - In addition, increased age was associated with increased risk of deficiency.
- Overall, these results highlight patient subsets at higher risk of vitamin C deficiency, which may prompt earlier intervention and avoid adverse effects of deficiency by assessing levels at diagnosis and throughout treatment.
- Further research is necessary to determine effects of certain cancers or treatments on vitamin C deficiency.

Responsible Conduct of Research

All individuals who assisted underwent human subjects to training to ensure that the patient data used for this research was protected and used safely and properly.

References

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