ORIGINAL ARTICLE

# Correlation between nutritional status values based on World Health Organization child growth standard values and serum albumin levels with wound healing: an observational study

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## ABSTRACT

**Introduction:** Cleft lip and/palate (CL±P) is a congenital disorder that affects the orofacial area, and often associated with problems like feeding difficulties, which may lead to poor nutritional status. Management of cleft lip (CL) requires surgical procedures and wound healing process. Factors influencing wound healing include nutritional status and albumin status. The aim of this study was to analyze the correlation between nutritional status values based on World Health Organization child growth standard values and serum albumin levels with wound healing as measured by Healing Index Scale. **Method:** This study was conducted on 40 patients with unilateral CL±P who underwent palatoplasty procedure. Participants were selected using a non-probability purposive sampling technique. Saliva samples were collected before palatoplasty and on postoperative day 7 to assess albumin levels, while wound healing was evaluated on day 7 using the Healing Index Scale. Data were analyzed using the Spearman rank correlation test. **Results:** The nutritional status of patients was predominantly normal in both preoperative (75%) and postoperative day 7 (60%) assessments. Wound healing on day 7 showed that most patients were in the good category (72.5%), while 11 patients (27.5%) were classified as poor. Correlation analysis revealed a very weak and non-significant relationship between WHO child growth standard scores and salivary albumin levels, as well as non-significant relationship between WHO CGS nutritional status and the day 7 healing index in patients undergoing palatoplasty. **Conclusion:** No significant correlation was found between nutritional status, salivary albumin levels, and wound healing outcomes in patients undergoing palatoplasty.

## KEYWORDS

Cleft palate, wound healing, WHO, child growth standards, salivary albumin, healing index scale

## INTRODUCTION

Cleft palate is one of the congenital abnormalities. This condition can cause problems for both patients and their parents.[1] Psychological impact is common when parents find out that their newborn has a cleft palate. The presence of a cleft palate can disrupt the growth and development of the patient.[1] Patients with cleft palate experience various challenges from birth to adulthood, with swallowing difficulties being one of the major concerns. During feeding, food or liquids may enter the nasal cavity, which disrupts the normal swallowing process. [1,2]

The incidence of oral clefts in the United States is estimated to be 1 in 700 births. These fissures are associated with racial predilection, with fewer Black individuals and more Asians and Native Americans. Males have more orofacial clefts than females with a ratio of 3:2.[1,3] Cleft lip and palate occur approximately twice as often in males than in females The incidence of cleft lip and palate palate is 1/1000 births, and 35% - 55% of cases involve cleft palate, with the incidence of cleft palate in Asia is 0.45-0.5/1000 births.[1,3]

Several factors are thought to be responsible for cleft palate. Genetic and multifactorial factors contribute to the occurrence of cleft palate. Genetic factors include autosomal recessive, autosomal dominant and X linked, while other factors causing cleft palate are external factors. These include alcohol consumption, smoking during pregnancy, phenytoin, retinoids and illicit drugs such as cocaine.[1,4]

The primary management of cleft palate is palatoplasty.[5] Two main goals of cleft palate repair during infancy are: (1) closure of the connection between the oral cavity and nasal cavity and (2) anatomical repair of the muscles within the soft palate, which serve as the means of normal speech production.[6] The surgical procedure results in a postoperative wound. The wound healing process progresses through several phases, including the inflammatory phase, proliferation phase and maturation phase. proliferation phase and maturation phase.[7]

The wound healing process is influenced by several important factors, including the patient's nutritional status.[8] Duarte et al. (2016) reported that children with cleft palate experience breastfeeding difficulties, which may reduce the quality of their nutritional status.[9.10]

Orofacial clefts are not considered a life-threatening condition requiring emergency surgery. An analysis of 600,000 records of primary cleft surgeries performed in low- and middle-income countries over a 10-year period showed that 28.6% of children were underweight at the time of primary cleft closure surgery.[11] Children with cleft lip and/or palate are at increased risk of impaired growth, particularly in body weight and overall nutritional status; however, appropriate surgical intervention and comprehensive multidisciplinary care may support gradual catch-up growth over time.[12]

Nutritional status in children can be evaluated using anthropometric measurements, which remain the standard approach for assessing growth and development. In Indonesia, the assessment of child nutritional status refers to the World Health Organization (WHO) Child Growth Standards for children aged 0–5 years.[13] Child Anthropometry Standards are based on body weight and length/height parameters consisting of 4 (four) indices, including Body Weight Index by Age (W/A), Body Length Index by Age or Height by Age (H/A), Body Weight Index by Body Length/Height (W/H) and Body Mass Index by Age (BMI/A).[14]

The ability of an organism to repair or regenerate tissue is a definite advantage for survival.[15] Any interruption in natural progress will result in abnormal wound healing.[16] Wounds are a significant health problem worldwide. In studies conducted in the United Kingdom and Denmark, there were approximately 3 to 4 people with 1 or more wounds per 1000 population. Many of these wounds become chronic. Delayed wound healing in certain populations can be prevented or improved with appropriate therapies.[17, 18] Existing therapies sometimes cannot prevent undesirable situations such as amputation, and even death. Nutritional status is one of the most important things in influencing wound healing, which can be seen from the child's WHO growth chart.[18]

Measuring nutritional status can also be done using several biological samples, including saliva. Saliva contains several biomarkers of nutritional status as a manifestation of nutrition, namely albumin. Biomarkers contained in saliva can be used clinically as biomarkers that help provide information about the prognosis and clinical diagnosis of several oral and systemic diseases.

Albumin is the most abundant circulating protein found in plasma. Albumin represents half of the total protein content, in other words, albumin is one of the indicators of a healthy individual, so the use of albumin levels is an indicator of proper nutritional status.[19,20] Research conducted by Galata et al. concluded that albumin levels strongly reflect a patient's nutritional status. In clinical practice, albumin is frequently utilized as a nutritional marker because it is rich in the essential amino acid tryptophan and has a relatively short half-life (2.5 days), allowing it to reflect rapid changes in nutritional status.[21] Furthermore, adequate albumin levels are crucial for optimal postoperative wound healing; poor albumin status has the potential to disrupt the speed of wound repair and negatively impact the patient's overall quality of life. [18, 19]

Serum albumin, primarily synthesized in the liver, is widely used as a marker of nutritional status and systemic health. Quantification or measurement of wound healing must be done properly and use the right scale to assess the wound healing process. There are several wound healing scales that are commonly used to measure patient wound healing on the oral mucosa including the healing index.[21]

This scale is designed to make it easier for healthcare professionals to visually evaluate wound healing. The healing index is a tool to assess wound healing of the oral mucosa that includes five parameters related to the wound healing process of the oral mucosa. This scale can be used to assess all types of postoperative trauma to the oral cavity. The scale has been used in recent studies that have investigated interventions aimed at assessing oral wound healing and postoperative care. Health professionals use several assessment scales but it is known that the healing index has been widely used in assessing wound healing and has been found to be sensitive in assessing oral wound healing.[21]

The aim of this study was to analyze the correlation between nutritional status values based on World Health Organization (WHO) child growth standard values and serum albumin levels with wound healing, as measured by Healing Index Scale, to wound healing based on the healing index in post- palatoplasty.

## METHODS

This study utilized a prospective observational design to analyze the correlation between nutritional status—assessed via WHO Child Growth Standards and salivary albumin levels—and wound healing outcomes following cleft palate surgery. The observation included preoperative assessments and postoperative follow-up on day 7. This study was conducted on 40 patients with unilateral CL±P who underwent palatoplasty.

Sampling was conducted using a non-probability purposive sampling technique to ensure the subjects were aligned with the specific research objectives. The inclusion criteria were: (1) patients diagnosed with unilateral cleft lip and palate (CL±P); (2) aged between 18 months and 5 years; (3) scheduled for primary palatoplasty; and (4) whose guardians provided informed consent. The exclusion criteria included: (1) patients with other congenital syndromes or systemic diseases that could compromise wound healing; (2) patients with a history of previous palatal surgery; and (3) subjects with incomplete follow-up data.

Preoperative nutritional status was measured using anthropometric assessments, specifically body weight and length/height. These measurements were then plotted and converted into Z-scores using the WHO Child Growth Standards to categorize patients' nutritional status.

To assess salivary albumin levels, unstimulated saliva samples were collected preoperatively and 7 days postoperatively. Due to the patients' young age, saliva was collected using a sterile pediatric absorbent swab placed in the floor of the mouth or buccal mucosa for 1 to 2 minutes. The samples were obtained at least 1 hour after the patients' last oral intake to minimize contamination. The swabs were then placed into designated collection tubes, centrifuged to extract the saliva and remove cellular debris, and stored at -20°C until biochemical analysis.

Wound healing was assessed 7 days after palatoplasty using the Healing Index Scale modified from Kocaman et al.[24] The collected data were processed and analyzed using IBM SPSS Statistics version 25.0 for Windows. The normality of the data distribution was assessed using the Shapiro-Wilk test. As the data were found to be non-normally distributed ($p < 0.05$), the correlation between variables was analyzed using the Spearman rank correlation test. Statistical significance was determined based on a p-value of $< 0.05$.

## RESULTS

The characteristics of the participants in this study include patient data consisting of gender, age, weight, height and head circumference. TTable 1 presents the summary of patient characteristics.

**Table 1. Summary of patient characteristics**

| Patient | Total (n= 40) |
|---|---|
| Gender | |
| Male | 25 (62.5%) |
| Female | 15 (37.5%) |
| | |
| Age (Month) | 28.4±12.1 |
| Mean±SD | 24 (18-59) |
| Median | |
| | |
| Body Weight (Kg) | 11.5± 2.4 |
| Mean±SD | 11(8.6-22.0) |
| Median | |
| | |
| Height (Cm) | 85.0± 12,1 |
| Mean±SD | 83(66-118) |
| Median | |
| | |
| Head Circumference | |
| (CM) | 47.7±5.0 |
| Mean±SD | 47 (41-68) |
| Median | |

Based on Table 1, male patients comprised the majority of the sample, with a proportion of 62.5% versus 37.5%. The mean patient age was 28.4 months, ranging from 18 to 59 months. The average body weight was 11.5 kg, mean height was 85 cm, and mean head circumference was 47.7 cm.

Frequency distribution of nutritional status based on WHO child growth standard criteria for nutritional status based on WHO child growth standards was classified into 2 categories, namely normal nutrition and malnutrition. The following are the results of calculating the nutritional status of patients based on WHO child growth standards.

**Table 2. Nutritional status result**

| Nutrional Status | Total (n=40) | Percentage (%) |
|---|---|---|
| Normal Nutrition | 30 | 75 |
| Malnutrition | 10 | 25 |
| Total | 40 | 100 |

According to WHO child growth standard criteria, 30 patients (75%) were categorized as normal and 10 patients (25.0%) were categorized as malnourished. Nutritional status based on albumin levels was also classified into two categories, namely normal and malnutrition. The distribution of patients' nutritional status based on salivary albumin levels at preoperative and postoperative day 7 is presented in Table 3.

Table 3 shows that the nutritional status of patients both before surgery and after surgery on day 7 was predominantly normal, with percentages of 75% and 60% respectively. Wound Healing based on Healing Index is summarized in Table 4.

**Table 3. Distribution of the nutritional status based on albumin levels**

| Albumin Nutritional Status | Total (n=40) | Percentage (%) |
|---|---|---|
| Pre-Op | | |
| Normal Nutrition | 30 | 75 |
| Malnutrition | 10 | 25 |
| Post POD 7 | | |
| Normal Nutrition | 24 | 60 |
| Under Nutrition | 16 | 40 |
| Total | 40 | 100 |

**Table 4. Wound healing data based on the healing index scale**

| Healing Index | Total (n=40) | Percentage (%) |
|---|---|---|
| Day-7 | | |
| Good | 36 | 90 |
| Poor | 14 | 10 |
| Total | 40 | 100 |

Wound healing on day 7 showed that the majority of patients were in the good category with a percentage of around 90%, while 4 patients (10%) were in the poor category.

**Table 5. Wound healing index on Post Operation Day 7 observation**

| Statistic | Correlation (r) | n | p-value |
|---|---|---|---|
| Albumin Pre OP | 0.539 | 40 | 0.001 |
| Albumin POD 7 | 0.623 | 40 | 0.001 |
| WHO CGS | 0.539 | 40 | 0.001 |
| Healing Index POD 7 | 0.345 | 40 | 0.001 |

Hypothesis testing was performed to determine whether there was a relationship between nutritional status calculated based on WHO CGS and albumin levels with wound healing using a healing index scale. Based on the results of the normality test, most data were not normally distributed.

Data were considered normally distributed if the probability value (p-value) was greater than 0.05. The normality test in this study used the Saphiro-Wilk test because the number of samples was less than 50. Based on the table,nutritional status (WHO CGS), salivary albumin levels, and wound healing data were not normally distributed, as can be seen from the probability value which is smaller than 0.05.

Therefore, hypothesis testing was conducted using the Spearman rank correlation test. The results of the correlation calculation between nutritional status based on the calculation of the WHO Child Growth Standard (CGS) with wound healing was analyzed using the Spearman rank correlation test with the help of the IBM SPSS version 26.0 program with a 95% confidence level.

**Table. 6 Relationship between WHO CGS nutritional status and wound healing index POD 7**

| WHO CGS | Healing Index (POD 7) | | Total | r | p |
|---|---|---|---|---|---|
| | Good | Poor | | | |
| Pre-OP | | | | | |
| Normal Nutrition | 28 (90%) | 2 (6.7%) | 30 (100) | 0.192 | 0.234 |
| Under Nutrition | 8 (80%) | 2 (20.0%) | 10 (100) | | |

Two variables were considered to be significantly correlated if they have a probability value (p-value) smaller than 0.05 and were considered to be insignificant if the probability value is greater than 0.05. Based on the calculation results in the table, the relationship between WHO CGS nutritional status and wound healing index POD 7 was not significant. This can be seen from the probability value showing a value greater than 0.05, which is 0.234.

The correlation coefficient was 0.192 indicating a very weak correlation. These results indicate that there was no significant relationship between nutritional status based on WHO CGS calculations and wound healing index. The correlation between nutritional status based on the calculation of salivary albumin levels with wound healing was also analyzed using the Spearman rank correlation test with the help of the IBM SPSS version 26.0 program with a 95% confidence level.

**Table 7. Relationship between nutritional status of salivary albumin levels with wound healing (healing index) day 7**

| Albumin Level | Healing Index (POD 7) | | Total | r | p |
|---|---|---|---|---|---|
| | Good | Poor | | | |
| POD-7 | | | | | |
| Normal Nutrition | 21 (87.5%) | 3 (12.5%) | 24 (100) | -0.102 | 0.531 |
| Under Nutrition | 15 (93.8%) | 1 (6.3%) | 16 (100) | | |

Based on the calculation results in Table 7, the relationship between nutritional status of salivary albumin levels with wound healing (healing index) day 7 was not significant. This can be seen from the probability value which shows a value greater than 0.05, which is 0.531. The correlation coefficient was -0.102, indicating a weak negative correlation. These findings indicate that there is no significant relationship between nutritional status based on the calculation of salivary albumin levels and wound healing (index).

## DISCUSSION

As shown in Table 1, the general characteristics of this study indicate that male patients dominated the sample, with a proportion of 62.5% compared to 37.5%. The average age of the patients was 28.4 months with the lowest age being 18 months and the highest being 59 months. The average body weight was 11.5 kg, the mean height was 85 cm and head circumference was 47.7 cm suffering from CB/CL. Research conducted by Fitrie et al. showed that the incidence of male CB/CL (58.1%) was more dominant than in females (41.9%).[20] Another study conducted by Khamila et al. found similar findings (58% males and 42% females).[22] Gender differences in the prevalence of CB/CL indicate that the prevalence in males is approximately twice that in females, while the prevalence of CL is about two-thirds higher in females.[23] This difference is attributed to variations in the timing of critical stages in craniofacial development between female and male embryos.[23]

Female palatal sheath shift occurs approximately half a week later than in male embryos, which increases the risk of CL. Pool et al. proposed a validated classification system that divides CB/CL subphenotypes into groups based on the underlying developmental mechanisms (fusion, differentiation, and timing of embryogenesis in both primary and secondary stages).[24] Pool et al. further reported that CB/CL is more prevalent in males than in females because males exhibit disturbances in both fusion and differentiation processes during early and late embryogenesis.[25]

Further general characteristics showed that the age of patients undergoing palatoplasty ranged from >18 months to 5 years. Research conducted by Fitrie et al. reported that the age distribution of CB / CL patients who performed labioplasty and palatoplasty included 497 patients (53.2%) aged < 12 months, 332 patients (35.6%) aged 12-36 months, and the rest older than 36 months.[26] The age variation in surgery timing can occur because optimal conditions cannot always be obtained in all patients. Patients with malnutrition and low birth weight (LBW) often experience difficulty in meeting the criteria for timely surgery. Determination of the optimal age of surgery depends on clinical judgment, including anesthesia risk, comorbidities and family readiness. The minimum age of 18 months is used as a reference for performing palatoplasty, so that the phase of speech skills can be corrected with the help of speech therapy. In this study, one-stage palatoplasty was performed by repairing the hard and soft palate simultaneously.

In this study, a one-stage palatoplasty was performed by repairing the hard and soft palate simultaneously. However, as noted by Fitrie et al., not all cases can be treated with a uniform surgical timeline.[20] Delays in palatoplasty are frequently necessitated by systemic factors, most notably poor preoperative nutritional status and inadequate body weight. This is consistent with findings by Tungotyo et al., who reported that malnutrition is highly prevalent among infants with cleft palate, often leading to postponed surgical interventions to mitigate anesthetic and wound healing risks.[5] Similarly, a systematic review by Nyakotey et al. emphasized that achieving a baseline nutritional standard is a critical prerequisite for cleft surgery to prevent severe postoperative complications.[7] Therefore, optimizing preoperative conditions, as reflected in the normal nutritional status and adequate salivary albumin levels observed in most of our cohort, remains a fundamental protocol before proceeding with surgery.[26]

Routine pre-surgical examinations were performed to identify any unexpected conditions that might alter surgical management. In this study, the preoperative laboratory results showed no significant abnormalities across the entire sample, confirming that the patients were optimally prepared for elective palatoplasty. The UK health technology assessment (HTA) defines "routine examination" as an examination performed on healthy, asymptomatic individuals, in the absence of specific clinical indications, to identify conditions not detected by history taking and clinical examination. The American Society of Anesthesiologist (ASA) states that pre-surgical examinations should not be performed routinely, but should instead be performed selectively based on clinical indications to optimize perioperative outcomes. Consequently, several studies have demonstrated that in the absence of clinical indications—meaning the patient is fundamentally healthy without symptoms of acute illness, congenital systemic diseases, or suspected bleeding disorders during physical examination—the likelihood of obtaining abnormal results is exceptionally small. In the context of palatoplasty, "abnormal results" refer to significant deviations in preoperative laboratory values, such as prolonged coagulation times or profound hypoalbuminemia, that would necessitate therapeutic intervention or a change in the surgical management plan.[26,27]

These abnormal results generally do not affect the surgical procedure. Anesthesia and surgical tolerance in children requires good planning and collaboration between pediatricians, surgeons, anesthesiologists, and other medical personnel. Indonesia's health technology assessment (HTA) in 2003 made recommendations for pre-surgical examinations for elective surgery. Supportive examinations that are recommended to be performed routinely in children are peripheral blood tests and hemostasis function. Blood chemistry, urinalysis, thoracic X-ray, electrocardiography, and pulmonary function tests are only performed if there is an indication.[27]

Bleeding time (BT), prothrombin time (PT) and partial thromboplastin time (PTT) are blood tests that are often performed before surgery. The presence of abnormal results without a clear clinical cause does not lead to changes in patient management. The limitation of the PT test is that it can only detect abnormalities when the concentration of the factor being assessed is <30%. Although this is the only hemostasis test performed in vivo, the results often do not reflect the bleeding period in organs other than the skin; therefore, it has low sensitivity and specificity. Clotting time is a test to determine the length of time it takes for blood to clot, or in other words, to assess the activity of factors that form thromboplastin, platelet-derived factors, and fibrinogen levels. Normal clotting time values vary by laboratory, generally ranging from 9-15 minutes. Post-surgical bleeding is generally caused by various factors, mainly related to surgical techniques, surgeon skills, and post-surgical patient behavior.[27]

The preoperative laboratory examinations in this study showed no significant abnormalities across the entire sample. This aligns with the American Society of Anesthesiologists advisory, which suggests that routine testing often yields low clinical utility in healthy patients undergoing elective procedures.[28] Similarly, Martin and Cifu noted that abnormal results in routine screenings are rare and seldom lead to changes in surgical management.[29] These findings suggest that preoperative screening does not necessarily reduce postoperative complications, as outcomes are more closely related to surgical technique, the surgeon's skill, and the patient's postoperative behavior rather than routine biochemical testing.

Research on WHO child growth standards, salivary albumin levels, and healing index scale measurements in patients with CB / CL has never been done before. In a study involving acutely ill patients, Eckart et al. concluded that serum albumin levels are significantly associated with overall nutritional status.[30]

While previous studies by Eckart et al. and Galata et al. found significant relationships between albumin and nutritional status, their subjects were largely acutely ill patients where physiological changes are drastic.[21,29] In contrast, the present study found no significant correlation. This discrepancy may be attributed to the clinical characteristics of our sample. The majority of participants in this study (75%) fell into the 'normal nutrition' category preoperatively. Unlike acutely ill populations, these elective surgery patients were relatively healthy and prepared for surgery, resulting in a lack of variance in nutritional status data.

This 'ceiling effect' in nutritional health might explain why the statistical correlation with wound healing was not significant in this specific cohort. While severe nutritional deficiency is well-documented to impair wound healing mechanisms,[26] recent literature suggests that essential wound repair can still proceed effectively in patients with mild variations in nutritional status, provided that specific protein requirements are met.[25]

In research subjects who had normal albumin levels, the proportion of non-healing wounds was much lower at 13.2% compared to healing wounds at 86.8%. This finding is in line with Pararesthi et al., who reported that subjects with abnormal albumin levels had a higher proportion of non-healing acute wounds at 68.2% compared to healing wounds at 31.8%.[12] This means that subjects with abnormal albumin levels are at greater risk of non-healing wounds compared to subjects with normal albumin levels. This is because in general, before surgery, efforts are made to optimize albumin levels by administering albumin when levels are low. Low albumin levels are an estimated cause of malnutrition and are also associated with increased complications and postoperative mortality. The wound healing process requires protein as the basis for collagen tissue, while an important component of protein is albumin.[28]

Adequate albumin levels in this study may prevent edema because albumin plays a role in the balance of osmotic and hydrostatic pressure.[21] Pharmacokinetics and drug distribution have an important relationship with drugs that bind to albumin. This will affect the half-life and metabolism time of free molecules which also have an impact on changes in their levels.[19,21] Other functions of albumin include are in plasma buffering, regulation of physiological pH defense, and prevention of folic acid degradation.[19]

Albumin reserves in the body can be supplemented with protein hydrolysates which provide amino acids and exert a strong insulinotropic effect, because insulin is an anabolic hormone that reduces protein splitting and increases amino acid absorption by muscles and tissues. In this study, protein hydrolysates, particularly casein, have been widely used to accelerate post-surgical healing and aid the repair of tissue damage. Protein hydrolysates have also been investigated for their benefits in tissue repair under conditions where natural foods cannot be digested or ingested in sufficient quantities, as they also provide a rich source of nutrients for the body to aid healing.[29]

The nutritional status of children is classified by the World Health Organization (WHO) as normal nutrition, undernutrition and overnutrition. This classification can be determined through anthropometric calculation values using the World Health Organization Child Growth Standards for children aged 0-5 years. Child Anthropometry Standards are based on body weight and length/height parameters consisting of Body Weight Index according to Body Length/Height (BB/PB or BB/TB).[13] Determination of nutritional status is based on body weight (BW) according to body length (PB) or height (TB) (BB/PB or BB/TB). The wound healing assessment was based on a photograph-based prospective study of oral mucosal healing.[30]

This study was conducted using non-random sampling with accidental sampling in appendicectomy wound healing patients with a total of 18 subjects. Nutritional deficiencies, particularly protein deficiency, significantly affect the wound healing process. This finding is consistent with Siswandi et al., who reported that nutritional status directly affects overall health and influences the wound healing process.[13] Protein is needed for wound healing and to rebuild various body tissues that have changed after undergoing surgery. Protein in the form of amino acids obtained from food sources is converted into collagen, which is used by fibroblasts for wound healing. Collagen synthesis is impaired in conditions of malnutrition, which results in impaired wound healing.[31,32]

Children with CP/CL have poor nutritional status due to defects in lip and palate anatomy. Children with CP/CL often experience impaired nipple/bottle sucking due to inadequate lip retention, resulting in inadequate negative pressure in the oral cavity, as well as failure in swallowing due to cleft palate causing regurgitation of milk. This condition can lead to low food intake. Socio-economic conditions and environmental factors are often associated with the incidence of children born with CP/CL. This finding is inline with research by Vu et al, which assessed maternal socioeconomic status and the risk of CP/CL in the United States, finding that the lower the socioeconomic level of the family, the greater the risk of CP/CL.[16] Lack of knowledge about healthy pregnancy and prenatal care in low socioeconomic mothers is a major factor in this condition. [33-35]

The examination of salivary albumin levels in this study was conducted preoperatively based on two primary considerations. First, patients with optimal preoperative nutritional status are theoretically more likely to achieve faster wound healing compared to those with malnutrition. Second, salivary albumin serves as a practical tool for evaluating and diagnosing a patient's nutritional status. Saliva offers a non-invasive diagnostic alternative to traditional blood sampling while accurately reflecting systemic physiological states. Current advancements in oral biology have validated saliva as a reliable medium for monitoring clinical biomarkers and nutritional health.

However, our findings—which showed no significant correlation between salivary albumin and the 7-day healing index—warrant further comparison with existing literature. This result differs from the study by Tanaka et al, which found that preoperative nutritional status was an independent predictor of wound healing in surgical patients.[17] The discrepancy may be attributed to the nature of the surgical site; while Tanaka et al. focused on ischemic tissue loss in general surgery, our study observed the oral mucosa, which possesses a unique healing capacity.[17]

Furthermore, research by Maciejczyk et al. supports the use of salivary biomarkers to reflect systemic inflammation and nutritional stress, yet they noted that salivary protein concentrations can be influenced by local factors in the oral cavity.[18] In our cohort, the lack of statistical significance might be due to the relatively normal salivary albumin values (average 0.66–0.8 g/dL) observed in the majority of patients (60%–75%), which provided sufficient protein for the initial stages of tissue repair regardless of minor variations. This suggests that while salivary albumin is a valid diagnostic tool, its sensitivity in predicting acute, short-term mucosal healing in otherwise stable pediatric patients may be limited compared to its role in chronic or systemic disease monitoring.[18]

Each major salivary gland is regulated by the autonomic nervous system. The serous part of the salivary gland is innervated by the sympathetic system and the mucosal part is innervated by parasympathetic and sympathetic stimuli resulting in salivary secretion. Parasympathetic stimulation leads to high salivary flow with lesser amounts of organic and inorganic compounds. Sympathetic stimulation results in protein-rich saliva. In cases where salivary components are derived from blood, the levels of biochemical and immunological components measured in saliva may reflect those in the blood.[33]

Malnutrition is a widespread health problem in today's society that has complex negative effects on various organ systems, functions, and physiological processes, including problems related to wound healing.[31] An important focus in this study is the relationship between malnutrition and abnormal wound healing in the oral cavity after palatoplasty surgery, with consideration of the underlying mechanisms in pediatric patients. Problems sometimes arise because obesity or excessive or insufficient fat deposition alters the cellular composition and tissue structure of fat, and changes the physiology of skin and mucosal tissue.

Obesity and malnutrition cause hypertrophy and hyperplasia of fat, which in turn impairs metabolic functions such as fat storage. Adipose tissue in healthy individuals is beneficial to the human body because it functions as an insulator and paracrine and endocrine organs that secretes cytokines, growth factors, and immune mediators. Uninjured adipose tissue has a vascular supply comparable to other tissues, but its lobular structure makes it more susceptible to mechanical damage when injured. Each lobule is supplied by a terminal blood vessel, damage to that area can lead to necrosis of the entire peripheral lobule of the wound. [30,33]

Adipose tissue expansion and its vascular supply are integral to tissue physiology. However, variations in fat deposition and nutritional status were not identified as significant postoperative risk factors in this study. This aligns with research by Lauwers et al, which demonstrated that nutritional variations do not necessarily negatively impact surgical outcomes in specific populations.[19] Hemostasis is a series of processes that occur as a physiological response to vascular injury and bleeding. Important events in this phase are vasoconstriction of blood vessels and the formation of temporary blood vessel plugs (platelet plug) called primary hemostasis and continues with the activation of the coagulation cascade to form a stable clot, known as secondary hemostasis.[21] In the palatoplasty wound healing process in this study is a secondary healing process carried out by the process of granulation or cell growth, contraction and epithelialization at the wound edge in the postoperative period.

The assessment in this study was conducted on acute wounds on day 7 where fibroblasts had begun to produce new collagen and glycosaminoglycans to help stabilize the wound, allowing re-epithelialization to begin with cell migration from the periphery of the wound edge. The wound healing process in the oral mucosa is influenced by the environment such as exposure to saliva and microbes in the oral cavity. External factors can contribute to wound healing in the oral cavity. The remodeling phase and scar tissue formation in the oral mucosa are generally better and faster than those of the skin.[25] This unique healing capacity is attributed to the humid environment and specific salivary factors that promote faster re-epithelialization with reduced inflammatory response compared to cutaneous wounds, human saliva has been shown to actively stimulate oral wound healing in vitro.[23,34]

Lauwers et al. conducted an in vivo assessment of malnutrition status based on the Global Leadership Initiative on Malnutrition (GLIM) in patients with diabetic foot ulcer (DFU) patients found in two European studies that the percentage of wound healing in malnourished patients improved overall after 6 months of evaluation. Malnutrition in diabetics is common, but no significant difference in wound healing was observed between well-nourished and malnourished patients.[19]

Although the adverse effects of malnutrition on wound healing are well known, additional research is needed to determine the comprehensive mechanisms involved in this relationship. The relationship between malnutrition and wound healing involves multiple factors, including growth factors, cytokines, nutritional manipulation, surgical technique, and genetic factors. Most likely, interventions will involve a combination of these and other factors. With the prevalence of obesity and malnutrition in today's society and its impact on healthcare, the challenge of altering the influence of adipose tissue on wound healing remains an area requiring further investigation.

The results of this study showed that patients generally maintained a normal nutritional status based on both WHO child growth standards and salivary albumin levels. Comparative analysis revealed an average salivary albumin value of 0.66–0.8 g/dL, with the majority of patients (60%) remaining in the normal category on day 7, as shown in Table 3. This aligns with research by Lauwers et al., which suggested that such nutritional variations do not necessarily impair clinical outcomes in specific surgical populations.[19] These findings confirm that salivary albumin is a viable non-invasive tool for monitoring the nutritional baseline in pediatric cleft patients.

In the recapitulation of nutritional status measurements based on WHO child growth standards for palatoplasty patients carried out after surgery. Table 4.2 shows that of the 40 patients, 75% were in the normal category, while 25.0% were classified as undernourished. Table 4 shows that the nutritional status based on salivary albumin of patients, both in preoperative and postoperative conditions on day 7, was predominantly within normal ranges, with percentages of 75% and 60% respectively. The results of this study indicate that the value of the healing index scale has no relationship with the WHO CGS value and salivary albumin levels, and therefore it cannot be concluded that the better the patient's nutritional status, the better the wound healing. Measurements in this study were carried out using the healing index scale in palatoplasty patients on day 7.

This study has several limitations that should be acknowledged. First, the sample size was relatively small (n=40) and limited to a single center, which may affect the generalizability of the findings. Second, the observation period was limited to 7 days post-surgery; while this captures acute healing, it does not account for long-term recovery or delayed complications. Third, the assessment of nutritional status relied solely on anthropometry and salivary albumin. Future research should consider a multicenter cohort design with a larger sample size and a longer follow-up period (e.g., 1–3 months). Additionally, incorporating other biochemical markers of nutrition and inflammation could provide a more comprehensive understanding of the mechanisms affecting oral wound healing, which could ultimately guide advanced targeted repair strategies, including emerging biomaterial-based drug delivery systems.[35]

## CONCLUSION

This study found no correlation between nutritional status measured by either WHO child growth standards and salivary albumin levels with the wound healing process in patients undergoing palatoplasty. The majority of the subjects exhibited normal nutritional status and achieved good wound healing outcomes by the seventh postoperative day. The implication of this research is that while nutrition remains a fundamental pillar of general health, mild variations in nutritional status among eligible elective surgical candidates do not appear to significantly alter short-term mucosal wound healing outcomes.

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## REFERENCES:

1. Hospital length of stay and probability of acquiring infection. J Health Organ Manag. 2023;4(4):324–338. https://doi.org/10.1108/17506121011095182
2. Masrial M, Yanwirasti Y, Syukur S, Syamsudin E. Analysis of gene polymorphisms TGFα rs1058213 to cleft lip cases with or without non-syndromic cleft palate in Riau Malay ethnic. J Dent Med Forensic Sci. 2018;3(1):32–36. https://doi.org/10.15562/jdmfs.v3i1.498
3. Papathanasiou E, Trotman C, Scott A, Van Dyke T. Current and emerging treatments for postsurgical cleft lip scarring: effectiveness and mechanisms. J Dent Res. 2017;96(12):1370–1377. https://doi.org/10.1177/0022034517717261
4. Mlambo S, Parkar H, Naude L, Cromarty A. Treatment of acute wounds and injuries: cuts, bites, bruises and sprains. S Afr Pharm J. 2022;89(1):12–18.
5. Tungotyo M, Atwine D, Nanjebe D, Hodges A, Situma M. The prevalence and factors associated with malnutrition among infants with cleft palate and/or lip at a hospital in Uganda: a cross-sectional study. BMC Pediatr. 2017;17(1):1–7. https://doi.org/10.1186/s12887-016-0775-7
6. Duarte GA, Ramos RB, Cardoso MCAF. Feeding methods for children with cleft lip and/or palate: a systematic review. Braz J Otorhinolaryngol. 2016;82:602–609. https://doi.org/10.1016/j.bjorl.2015.10.020
7. Nyakotey D, Apprey C, Annan R. Malnutrition in children with unrepaired orofacial cleft: a systematic review. Int J Public Health Clin Sci. 2019;6(3):67–76. https://doi.org/10.32827/ijphcs.6.3.67
8. Chen LR, Yang BS, Chang CN, Yu CM, Chen KH. Additional vitamin and mineral support for patients with severe burns: a nationwide experience from a catastrophic color-dust explosion event in Taiwan. Nutrients. 2018;10(11):1782. https://doi.org/10.3390/nu10111782
9. Yuwen P, Chen W, Lv H, et al. Albumin and surgical site infection risk in orthopaedics: a meta-analysis. BMC Surg. 2017;17(1):1–9. https://doi.org/10.1186/s12893-016-0186-6
10. Pool SM, van der Lek LM, de Jong K, Vermeij-Keers C, Mouës-Vink CM. Embryologically based classification specifies gender differences in the prevalence of orofacial cleft subphenotypes. Cleft Palate Craniofac J. 2021;58(1):54–60. https://doi.org/10.1177/1055665620935363
11. Eckart A, Struja T, Kutz A, et al. Relationship of nutritional status, inflammation, and serum albumin levels during acute illness: a prospective study. Am J Med. 2020;133(6):713–722.e7. https://doi.org/10.1016/j.amjmed.2019.10.031
12. Kinter S, Meehan A, Ormanidou I, et al. Systematic review of growth in young children with cleft lip and/or cleft palate from 0 to 24 months of age. Cleft Palate Craniofac J. 2025. https://doi.org/10.1177/10556656251365012
13. World Health Organization, United Nations Children's Fund (UNICEF), World Bank Group. Levels and trends in child malnutrition: UNICEF/WHO/World Bank Group joint child malnutrition estimates 2023. Geneva: World Health Organization; 2023.
14. Haider A, Wei Y, Zheng J, Lin H, Jiang X, Yang G, et al. Innovative treatment strategies to accelerate wound healing: trajectory and recent advancements. Cells. 2022;11(15):2439. https://doi.org/10.3390/cells11152439
15. Goswami M, Jangra B, Bhushan U. Management of feeding problem in a patient with cleft lip/palate. Int J Clin Pediatr Dent. 2016;9(2):143–146. https://doi.org/10.5005/jp-journals-10005-1351
16. Vu GH, Warden C, Zimmerman CE, et al. Poverty and risk of cleft lip and palate: an analysis of United States birth data. Plast Reconstr Surg. 2022;149(1):169–182. https://doi.org/10.1097/PRS.0000000000008636
17. Tanaka K, Tanaka S, Okazaki J, Mii S. Preoperative nutritional status is independently associated with wound healing in patients undergoing open surgery for ischemic tissue loss. Vascular. 2021;29(6):897–904. https://doi.org/10.1177/1708538120980216
18. Maciejczyk M, Bielas M, Zalewska A, Gerreth K. Salivary biomarkers of oxidative stress and inflammation in stroke patients. Oxid Med Cell Longev. 2021. https://doi.org/10.1155/2021/5545330
19. Lauwers P, Hendriks JM, Van Bouwel S, et al. Malnutrition according to the 2018 GLIM criteria is highly prevalent in people with a diabetic foot ulcer but does not affect outcome. Clin Nutr ESPEN. 2021;43:335–338. https://doi.org/10.1016/j.clnesp.2021.03.029
20. Fitrie RN, Hidayat M, Dahliana L. Incidence of cleft lip with or without cleft palate at YPPCBL 2016–2019. J Med Health. 2022;4(1):12. https://doi.org/10.28932/jmh.v4i1.3396
21. Galata C, Busse L, Birgin E, Weiß C, Hardt J, Reißfelder C, et al. Role of albumin as a nutritional and prognostic marker in elective intestinal surgery. Can J Gastroenterol Hepatol.2020. https://doi.org/10.1155/2020/7028216
22. Khamila N, Nurwiadh A, Putri FA. Characteristic of cleft lip and palate at Cleft Center of Padjadjaran University Dental Hospital: 2 years retrospective study.
23. Hudwekar AD, Beldar A, Murkute S, Lendhey SS, Thamke MJ. Aloe vera on wound healing after periodontal flap surgery in chronic periodontitis patients: a randomized controlled trial. J Oral Res Rev. 2019;11(2):72–76. https://doi.org/10.4103/jorr.jorr_14_19

24. Kocaman G. A comparative evaluation of the effects on postoperative pain of systemic and topical forms of benzydamine hydrochloride after periodontal flap surgery: a randomized controlled clinical trial. Med Sci Discov. 2020;7(2). https://doi.org/10.36472/msd.v7i2.345
25. Politis C, Park JC, Sennhenn-Kirchner S, Scheuschner P. Wound healing problems in the mouth. Front Physiol. 2016;7:507. https://doi.org/10.3389/fphys.2016.00507
26. Rodriguez-Merchan EC. Factors influencing wound healing. J Clin Med. 2022;11(20):6155. https://doi.org/10.3390/jcm11206155
27. O'Neill F, Carter E, Pink N, Smith I. Routine preoperative tests for elective surgery: summary of updated NICE guidance. BMJ. 2016;354:i3292. https://doi.org/10.1136/bmj.i3292
28. American Society of Anesthesiologists. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. Anesthesiology. 2020;133(2):284–352. https://doi.org/10.1097/ALN.0000000000003343
29. Martin SK, Cifu AS. Routine preoperative laboratory tests for elective surgery. JAMA. 2017;318(6):567–568. https://doi.org/10.1001/jama.2017.7508
30. Fournier BPJ, Nguyen NE, Durand R, Nishio C, Strippoli J, Carra MC, et al. Oral mucosal wound healing: a photograph-based prospective study. J Periodontol. 2026. https://doi.org/10.1002/jper.70063
31. Chen Y, Gao B, Cai W, Lai J, Lai K, Wang Y. Oral mucosa: anti-inflammatory function, mechanisms, and applications. J Mater Chem B. 2025;13:4059–4072. https://doi.org/10.1039/D4TB02845G
32. Bergsma JE. Wound healing of the oral mucosa: process, factors affecting healing and complications. Ned Tijdschr Tandheelkd. 2024;131(3):101–105. https://doi.org/10.5177/ntvt.2024.03.23076
33. Manikandan R, Anantanarayan P, Kumar DN, Ponvel K. Oral wound healing: a scoping review and proposal of a new index for palatal mucosa. J Maxillo Oral Surg. 2024;23(2):416–423. https://doi.org/10.1007/s12663-023-02052-w
34. Rodrigues Neves C, Buskermolen J, Roffel S, Waaijman T, Thon M, Veerman E, et al. Human saliva stimulates skin and oral wound healing in vitro. J Tissue Eng Regen Med. 2019;13(6):1079–1092. https://doi.org/10.1002/term.2865
35. Yu J, Li X, Fu X, Wen J, Jiang Y, Kuang Q, et al. Targeted repair of oral mucosal injury: emerging applications of biomaterials-based drug delivery systems. J Nanobiotechnol. 2026;24:216. https://doi.org/10.1186/s12951-026-04117-7