



Hand Grip Strength Test and Prognostic Nutritional Index as Predictors of Length of Stay in Patients Undergoing Colorectal Surgery

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Abstract: Ability to identify patients at risk of extended hospital stays before surgery is crucial so interventions can be made to reduce morbidity and complication rates leading to a shorter length of stay (LOS) postoperatively. Handgrip strength test (HGS) is considered to represent overall muscle strength and as a predictor of overall body strength. Prognostic nutritional index (PNI) is used to assess nutritional and immune status and has the ability to accurately predict complications and assess the prognosis of postoperative in malignancy. This study aimed to determine whether HGS and PNI could predict LOS in colorectal cancer patients undergoing colorectal surgery. Correlations between HGS and LOS and PNI and LOS were analyzed using non-parametric regression with Spearman Rank while correlation between HGS and PNI was analyzed using the Pearson correlation test. The results obtained 30 patients consisting of 19 males and 11 females (mean age 54.9 ± 8.9 years). The mean LOS after surgery was 8.10 ± 3.13 days. A statistically significant negative correlation between HGS and LOS was found ($r = -0.414$, $p = 0.023$), indicating that the lower the HGS, the longer the LOS. The relationship between PNI and LOS also showed a statistically significant negative correlation ($r = -0.481$, $p = 0.007$), indicating that higher PNI was associated with shorter LOS. Correlation between HGS and PNI showed positive but weak ($r = 0.290$, $p = 0.120$) with a confidence interval of -0.078 – 0.589 . In conclusion, HGS and PNI are significantly associated with the patient's LOS and can be used as predictors of the duration of LOS in post-colorectal surgery patients. Both can help health practitioners to assess patients with a potential risk of extended hospital stays before colorectal surgery so interventions can be made to reduce morbidity and complication rates leading to a shorter length of stay postoperatively.

Keywords: colorectal surgery; handgrip strength test; prognostic nutritional index

INTRODUCTION

The length of stay (LOS) after surgery is an important factor that become a benchmark for surgical success. If LOS can be predicted before surgery, interventions can be made to reduce the risk. This is crucial as this facilitates healthcare resources allocation, post operative management, better quality of life, and reduces cost. Strategies such as improved recovery and prehabilitation as good clinical practice have the potential to lower morbidity rates,¹ leading to reduced LOS.

Colorectal cancer is one of the leading causes of death in the world. In 2022, the number of new cases of colorectal cancer in Indonesia has increased compared to 2020. In men there were 21.764 in 2020 to 21.903 new cases in 2022, and in women there were 12.425 in 2020 to 13.773 new cases in 2022.²

The average post-colorectal surgery hospitalization period was 6-11 days.³ A practical, reliable and repeatable bedside test is needed that can predict LOS after colorectal cancer surgery. Handgrip strength (HGS) is considered to represent overall muscle strength and as a predictor of overall body strength. The HGS is a simple test and can be used for clinical judgment in identifying patients at risk of complications after surgery. Mahalakshmi et al⁴ concluded that patients with abnormal HGS require urgent preoperative correction to reduce the risk of complications.

In 1980, Buzby et al⁵ introduced a prognostic nutritional index (PNI) that provided accurate risk estimation of surgical complications and allowed rational selection of patients who required preoperative nutritional support. After that, in 1984 Onodera et al⁶ simplified the PNI and used only albumin and total lymphocyte counts as parameters. The formula was $PNI = [(10 \times Alb.(g/dL)) + (0.005 \times \text{total lymphocytes})]$. Their study on gastrointestinal cancer patients showed that PNI could accurately depict postoperative complication risk. Meanwhile, according to Nozoe et al⁷ in 2010, PNI could be used as independent prognostic indicator in gastric carcinoma. Moreover, Santoso et al⁸ reported that there was a correlation between PNI and length of stay in malnutrition oncology gynecology patients.

Studies show that low HGS rates are independent predictors of poor postoperative prognosis of gastrectomy in gastric cancer patients and can be used to predict postoperative morbidity.^{9,10} In a 2019 study stated that HGS can predict LOS in patients after hepatobiliary surgery.¹¹ Therefore, the purpose of this study is to find out whether HGS and preoperative PNI can be used to predict LOS in postoperative colorectal patients. We hypothesize that colorectal patients with lower HGS and low prognostic nutrient index will undergo longer postoperative LOS.

METHODS

We conduct a cross-sectional study in colorectal cancer patients who underwent all surgical procedures with the aim of removing the tumor, cutting the intestine, and performing intestinal grafting, as well as creating a stoma. A total of 30 patients aged between 34 and 64 years old who were admitted to Prof. Dr. R. D. Kandou General Hospital in Manado, Indonesia, from August 2024 to January 2025. Subjects with heart and lung disorders, diabetes mellitus, hyperthyroidism, hypertension, impaired kidney function, hepatic cirrhosis, anemia and leukemia, and a pathological condition of the hand or elbow of the dominant hand were excluded.

The PNI was calculated based on pre-operative laboratory findings. HGS was measured a day before surgery using Camry dynamometer model EH 101. The subject was introduced to a dynamometer test device. The dynamometer was adjusted so that the second joint of the index finger was in the handgrip at the right angle, and had to make sure that the screen showed the number 0. Measurements were taken on the dominant hand in a standing position with one leg forward or sitting comfortably and arms crossed across the abdomen. Subject then instructed to squeeze the dynamometer handgrip as firmly as possible then removed it. Procedure was repeated three times. The results recorded in kilograms. The highest value was taken for use in the analysis.¹² Postoperative LOS was summated from the day of surgery to the day of discharge alive.¹³

Correlations between HGS and LOS and PNI and LOS were analyzed using non-parametric regression with Spearman Rank. Correlation between HGS and PNI was analyzed using the

Pearson correlation test. For statistical analysis, the level of significance alpha-value was set at 0.05 and all analysis was two-tailed.

RESULTS

There were 30 colorectal cancer patients undergoing surgery from August 2024 to January 2025 consisted of 19 men (63.33%) and 11 women (36.66%) with an age range between 34 and 64 years. Table 1 showed the sample age characteristics and the average measurement values of handgrip strength (HGS), prognostic nutritional index (PNI), and length of stay (LOS) postoperatively.

Table 1. Sample age characteristics and the average measurement values

Subject characteristics	Male	Female	Total
Number	19	11	30
Age	56,3± 8,4	52,4 ± 9,0	54,9 ± 8,9
HGS (kg)	26,78±7,57 (9,9-37,3	19,2±3,84 (8,7-23,7)	24,01±7,55 (8,70-37,30)
PNI	43,76±9,24 (31,8-66.6	41,25±7,99 (24,38-55,83)	42,84±9,04 (24,38-66,60)
LOS (days)	7,26±2,38 (4-11)	9,54±3,57 (5-19)	8,10±3,13 (4,00-19,00)

Table 2 showed a significant negative correlation between HGS and LOS ($r=-0.414^*$, $p=0.023$), meaning that for every increase in the HGS variable, the LOS would decrease, and vice versa, for every decrease in the HGS variable, the LOS will increase.

Table 2. HGS and LOS regression equation models

			HGS in kg	LOS postoperative
Spearman's rho	HGS in kg	Correlation Coefficient	1.000	-.414*
		Sig. (2-tailed)	.	.023
		N	30	30
	LOS postoperative	Correlation Coefficient	-.414*	1.000
		Sig. (2-tailed)	.023	.
		N	30	30

* Correlation is significant at the 0.05 level (2-tailed)

Table 3 showed a significant negative correlation between PNI and LOS was found ($r=0.481^{**}$, $p=0.007$), meaning that for every increase in the PNI variable, the LOS would decrease, and vice versa, for every decrease in the PNI variable, the LOS would increase.

Table 3. PNI and LOS regression equation models

			PNI	LOS post operative
Spearman's rho	PNI	Correlation Coefficient	1.000	-.481**
		Sig. (2-tailed)	.	.007
		N	30	30
	LOS postoperative	Correlation Coefficient	-.481**	1.000
		Sig. (2-tailed)	.007	.
		N	30	30

**Correlation is significant at the 0.01 level (2-tailed)

Table 4 and 5 showed the correlation between HGS and INP. The results ($r=0.290$, $p=0.120$, 95% CI=-0.078–0.589) indicate a positive correlation, but there is not enough evidence to state that there is a statistically significant effect. A negative value (-0.078) indicates the possibility of

a negative effect, while a positive value (0.589) indicates a possible positive effect thus it cannot be determined in a clear direction.

Table 4. HGS and INP regression equation models

		HGS in kg	PNI
HGS in kg	Pearson Correlation	1	.290
	Sig. (2-tailed)		.120
	N	30	30
PNI	Pearson Correlation	.290	1
	Sig. (2-tailed)	.120	
	N	30	30

Table 5. Confidence intervals

	Pearson correlation	Sig. (2-tailed)	95% Confidence Intervals (2-tailed) ^a	
			Lower	Upper
HGS in kg - PNI	.290	.120	-.078	.589

^a. The estimate is based on Fisher's r-to-z transformation.

DISCUSSION

Handgrip strength (HGS) is a simple, inexpensive and easy-to-perform measurement. In one study, it was stated that preoperative HGS measurement can be considered as a strong predictor for postoperative LOS in post-esophagectomy.¹⁴ Other studies have also shown that low HGS are associated with poor postoperative outcomes, including morbidity, mortality and LOS.¹⁵ A number of clinical and epidemiological studies have shown the predictive potential of hand grip strength against mortality, short-term, and long-term morbidity. Decreased grip strength is also an indicator of higher postoperative complications, longer hospital stays, increased rehospitalization rates, and decreased physical condition.¹⁶

The average postoperative LOS in this study was 8.1 days, which is in accordance with a study conducted by Rawlinson et al³ where the postoperative LOS in colorectal cancer patients was 6-11 days. In this study, the correlation coefficient (r)=-0.414 showed that HGS had an inversely proportional relationship with LOS after colorectal surgery. The lower the HGS, the higher the LOS postoperative (Table 2).

Buzby et al⁵ in 1980 introduced the prognostic nutritional index with the formula: $PNI\% = 158 - (16.6 \times Alb \text{ (g/L)}) - (0.78 \times (TSF)) - (0.20 \times (TFN)) - (5.8 \times (DH))$. Onodera et al⁶ then simplified this prognostic nutritional index in 1984, which provided an accurate picture of surgical risk with the formula: $PNI = [(10 \times Alb \text{ (g/dL)}) + (0.005 \times \text{total lymphocytes})]$. The results of his research stated that gastrointestinal surgery could be done with good results if the PNI was >45. The same procedure had a greater risk of complications in PNIs between 45 and 40. Surgery in patients with a PNI of <40 was a contraindication.⁶ The average PNI in this study is 42.8476, which, based on Onodera research, has a greater potential for complications.

Poor nutritional status has an effect on morbidity and mortality and leads to longer hospital stays. Nutritional status is also associated with postoperative complications that lead to a longer recovery period. This is in accordance with a 2006 German study by Pirlich et al¹⁶ that concluded that patients with malnutrition have a longer hospital stay than patients with better nutrition.

Compared to other nutritional indexes, PNI was chosen by the researchers because it was only calculated from serum albumin and total lymphocyte count, two tests that have been routinely performed on patients who will undergo surgery. The combination of simplicity in calculation, routine laboratory parameters, and the ability to reflect the nutritional and immunological status of patients makes PNI considered by researchers for clinical applications.

The correlation between PNI and LOS in patients undergoing colorectal cancer surgery was obtained with a correlation coefficient value (r) = -0.481, where a negative sign (-) means an

inverse or non-unidirectional correlation, and a significance value, or sig. or p-value (2-tailed), is 0.007, which is smaller than 0.05 (Table 3), meaning there is a significant correlation. This indicates that the preoperative INP value can affect postoperative LOS. This significant correlation answers the researchers' hypothesis that INPs are able to predict postoperative LOS in colorectal cancer patients.

This study also shows that the correlation between HGS and INP (Table 4 and Table 5), the value of $r = 0.290$, is a positive value that indicates a relationship that is directly proportional. A p-value of 0.120, where >0.05 , indicates an insignificant value, and the Confidence Interval (or 95% CI) = $-0.078-0.589$ indicates that there is not enough evidence to declare that there is a statistically significant effect. Since the two values are in the same range, it cannot be determined in a clear direction. This finding also shows the same results as the research conducted by Chites et al,¹⁷ stating that reduced hand grip strength in patients did not show satisfactory accuracy in identifying malnutrition.

Shorter LOS shows effective and efficient health service performance so as to reduce hospital resources and reduce financial burden.¹³ In addition, reducing LOS also prevents patients from the risk of nosocomial infections and improves the patient's quality of life. The clinical application of this study allows doctors to recognize patients who are at high risk of undergoing long LOS before surgery so that appropriate interventions can be carried out to optimize patients and lower LOS.¹⁸

There were several limitations in this study. All of the subjects were limited to a certain population in a single province in Indonesia. A suggestion for this issue is to perform a multicenter study to obtain larger samples. Correlation between HGS and PNI that indicates an insignificant value and shows not enough evidence to declare that there is a statistically significant effect. This may be due to the non-similar staging of cancers in the samples, not separated into specific groups based on staging. In this study, stage 1 and stage 4 colorectal cancer were included in one population. The author suggests dividing the sample into a group based on the staging of the cancer.

CONCLUSION

Handgrip strength (HGS) and prognostic nutritional index (PNI) are significantly associated with the patient's length of stay (LOS), and can be used as predictors of the duration of LOS in post-colorectal surgery patients. This HGS serves as a simple and cost-efficient tool but shows a poor accuracy in identifying malnutrition. Meanwhile, PNI is a simple measurement used to assess nutritional and immune status. Both can help health practitioners to assess patients with a potential risk of extended hospital stays before colorectal surgery so interventions can be made to reduce morbidity and complication rates leading to a shorter LOS postoperatively.

Conflict of Interest and AI-assisted Technologies

The authors declare no conflict of interest and AI-assisted technologies used in this study.

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