ITN Morbidity/ Mortality Analysis Brief:

Methodology:

1. Dataset created and used for analysis can be found [here](#) (AC: All cases, U5: Under 5)

   Brands distributed in campaigns were grouped into three types, based on their manufacturing and insecticide type:

   - **PBO Combination** (DAWA Plus 2.0, DuraNet Plus, Permanent 3.0)
   - **Standard Pyrethroid** (Royal Sentry, DuraNet, OlysetNet, Yorkool)
   - **Dual Insecticide** (SafeNet, IG2 PBO)

2. Created two **linear mixed-effects models that** examined the association between different types of ITNs, the year, age group (AC or U5), and morbidity/mortality rates, accounting for variation across provinces.

```
# Model 1: Mixed-Effects Model for Morbidity
lme_morbidity <- lmer(value ~ Has_Standard_Pyrethroid + Has_PBO_Combination + Has_Dual_Insecticide + Year + Group +
                      (1 | Province), data = data_morbidity)


# Model 2: Mixed-Effects Model for Mortality
lme_mortality <- lmer(value ~ Has_Standard_Pyrethroid + Has_PBO_Combination + Has_Dual_Insecticide + Year + Group +
                      (1 | Province), data = data_mortality)
```

Potential Research Questions

Given the finding below, here are some research questions the model could help answer:

1. **Effect of ITN Types on Morbidity/Mortality**: How do different types of insecticide-treated nets (ITNs) affect mortality rates? Are there significant differences in mortality rates associated with standard pyrethroid, PBO combination, and dual insecticide nets?

2. **Yearly Trends in Morbidity/Mortality**: Is there a trend in mortality rates over the years (2020-2023)? Are mortality rates decreasing as new interventions are introduced?

3. **Impact on Vulnerable Groups**: How does morbidity/mortality among children under 5 compare to the general population? Are interventions like ITNs more effective in reducing morbidity/mortality in this age group?

4. **Provincial Variability**: How much variability in morbidity/mortality rates exists across provinces, and what factors might contribute to this variability?

MORBIDITY:

Fixed Effects Table: These coefficients tell you how much the predictors are associated with changes in the morbidity (incidence rate).

Predictor	Estimate	Standard Error	Interpretation
(Intercept)	26.0802	2.7293	Baseline morbidity rate when all predictors are zero.
Standard Pyrethroid	-3.3663	2.2068	Associated with a decrease in morbidity, but not significant (t = -1.525).
PBO Combination	-4.1205	2.6313	Associated with a decrease in morbidity, but not significant (t = -1.566).
Dual Insecticide	2.5210	2.0075	Associated with an increase in morbidity, but not significant (t = 1.256).
Year 2021	**-1.9050**	**0.6692**	**Estimated morbidity rate is 1.905 units lower in 2021 compared to 2020; significant (t = -2.847).**
Year 2022	0.8705	0.6692	Estimated morbidity rate is 0.8705 units higher in 2022 compared to 2020; not significant (t = 1.301).
Year 2023	0.7306	0.6889	Estimated morbidity rate is 0.7306 units higher in 2023 compared to 2020; not significant (t = 1.060).
Under 5 Age Group	**-11.4060**	**0.4732**	**Associated with a substantial decrease in morbidity for the U5 group; highly significant (t = -24.104).**

Random Effects:

- **Variance**: The variability in morbidity rates across different provinces is relatively high (6.487), indicating significant differences in baseline morbidity levels between provinces.

- **Residual**: The variance (4.478) indicates the unexplained variability in morbidity rates after accounting for the fixed effects in the model.

Scaled Residuals:

- These values help assess the model fit. Ideally, they should be centered around zero, indicating that the model is fitting well. The minimum scaled residual is -2.1687 and the maximum is 2.6025, suggesting some potential outliers. The median residual (-0.1224) being close to zero indicates that the overall predictions are reasonable, but the presence of extreme values suggests areas for further investigation.

MORTALITY:

Fixed Effects Table: These coefficients explain how much the predictors are associated with changes in the mortality rate.

Predictor	Estimate	Standard Error	Interpretation
(Intercept)	0.1458	0.0663	This is the baseline mortality rate when all predictors are zero.
Standard Pyrethroid	-0.0051	0.0472	Having standard pyrethroid nets is associated with a slight decrease in mortality, but the effect is not significant (t-value = -0.108).
PBO Combination	-0.0613	0.0567	Having PBO combination nets is also associated with a slight decrease, but not significantly (t-value = -1.080).
Dual Insecticide	-0.0465	0.0422	Dual insecticide nets show a slight decrease in mortality, not significant (t-value = -1.103).
Year	2021: -0.065 2022: -0.066 2023: -0.068	0.0477 0.0477 0.0480	The negative coefficients for 2021, 2022, and 2023 suggest that mortality rates may be decreasing over time compared to 2020. However, this is not statistically

Predictor	Estimate	Standard Error	Interpretation
			significant (t-values: -1.36, -1.39, -1.44, respectively).
Under 5 Age Group	-0.0395	0.0337	Being in the U5 (under 5 years) group is associated with a slight decrease in mortality, not significant (t-value = -1.170).

Random Effects:

- **Variance**: The variability in mortality rates across different provinces is very low (6.347e-05), indicating that the province effect is minimal in this model.

- **Residual**: The variance (2.278e-02) indicates the unexplained variability in mortality rates after accounting for the predictors.

Scaled Residuals:

- The scaled residuals range from -0.8576 to 8.0635. The distribution of the residuals suggests that while the model fits well for most observations, attention should be paid to any extreme outliers that could influence the overall conclusions.

Conclusion: Effect of ITN Types on Morbidity/Mortality Across Provinces:

The models indicate that different types of insecticide-treated nets (ITNs) have varying impacts on morbidity and mortality rates. Specifically, the coefficients for standard pyrethroid and PBO combination nets suggest no significant reduction in mortality associated with these ITNs, as both showed negative estimates but were not statistically significant. On the other hand, dual insecticide nets demonstrated a positive effect, although it was also not statistically significant. This suggests that while there may be some advantages to certain ITN types, the differences in their effects on mortality rates are not conclusive in this dataset. The variability in effects across provinces suggests that other factors, such as local healthcare access, malaria prevalence, and adherence to ITN programs, may play a more substantial role in influencing morbidity and mortality rates than the type of ITN alone.