There are several valuable analyses you can perform using the `grouped by air yards` and `money down` DataFrames. These analyses can offer insights into play-calling strategies and their effectiveness in critical situations, like 3rd and 4th downs. Here's a breakdown of potential analyses:

### 1. \*\*Air Yard Distribution Analysis (Grouped by Air Yards)\*\*

- \*\*Objective\*\*: Understand the distribution of first downs based on the depth of the pass (air yards).

- \*\*Analysis\*\*:

- \*\*Short Passes Success\*\*: Evaluate the success rate of short passes (e.g., air yards ≤ 3) versus deep passes (e.g., air yards > 7) in achieving first downs. This can help identify if short passes are being used more effectively in these critical downs.

- \*\*Chunk Plays\*\*: Examine how often chunk plays (e.g., passes > 7 air yards) are resulting in first downs on 3rd or 4th down.

- \*\*Efficiency of Negative Air Yards\*\*: Investigate how often passes with negative or zero air yards (e.g., screens or dump-offs) result in a first down.

- \*\*Insights for Play Design\*\*: Teams may optimize passing strategies based on air yard trends. If certain air yard ranges have low success, it could indicate room for improvement in play-calling or execution in those scenarios.

### 2. \*\*First Down vs. Turnover on Downs by Play Type (From Money Down Data)\*\*

- \*\*Objective\*\*: Analyze how successful the offense is on 3rd and 4th down situations based on play type (run vs. pass).

- \*\*Analysis\*\*:

- \*\*Play Type Effectiveness\*\*: Compare the success rate of run vs. pass plays on money downs. Which play type is more likely to convert a 3rd or 4th down?

- \*\*Down and Distance\*\*: Investigate whether the effectiveness of certain play types varies depending on the yardage needed for a first down. For example, are runs more successful when 1-2 yards are needed, but passes more successful when more than 2 yards are required?

- \*\*Coaching Strategy\*\*: Use this data to suggest how coaching staffs might optimize their play-calling on money downs, based on historical success rates of certain plays in similar situations.

### 3. \*\*Success Rate by Yardage to Go (Money Down)\*\*

- \*\*Objective\*\*: Determine how the required yardage (ydstogo) affects the likelihood of converting a 3rd or 4th down.

- \*\*Analysis\*\*:

- \*\*Short vs. Long Yardage Success\*\*: Assess how success rates change as the distance to go increases. Are teams more successful when they need 1-3 yards versus 4-7 yards on critical downs?

- \*\*Play Type in Context\*\*: Are run plays more successful when less yardage is required (e.g., 1-3 yards), and pass plays more successful when more yardage is required (e.g., 4+ yards)?

- \*\*Actionable Insights\*\*: Teams can use this analysis to inform decisions about whether to call a run or pass based on how far they are from the first down marker, especially in high-leverage situations.

### 4. \*\*Turnover on Downs Analysis (From Money Down Data)\*\*

- \*\*Objective\*\*: Investigate the frequency and causes of turnovers on downs in different yardage situations and play types.

- \*\*Analysis\*\*:

- \*\*High-Risk Play Types\*\*: Identify if certain play types, such as runs or deep passes, have a higher risk of resulting in a turnover on downs, especially in certain yardage situations.

- \*\*Yardage Patterns in Turnovers\*\*: Do turnovers on downs happen more frequently when the yardage to go is greater? This could highlight when teams are more likely to fail on 3rd or 4th down attempts.

- \*\*Improving Risk Management\*\*: Teams can minimize turnovers on downs by identifying patterns in which situations and play types are riskier and adjusting strategies accordingly.

### 5. \*\*Conversion Rate by Down (3rd vs. 4th Down)\*\*

- \*\*Objective\*\*: Compare conversion rates between 3rd and 4th downs.

- \*\*Analysis\*\*:

- \*\*Down Analysis\*\*: Are teams more or less likely to convert on 4th down compared to 3rd down? This can help understand how aggressive teams are and how successful they are in different high-pressure situations.

- \*\*Play Type by Down\*\*: Examine if there are differences in the types of plays called on 3rd down vs. 4th down. For instance, do teams favor passes more on 4th down when they’re desperate to convert?

### 6. \*\*Effect of Air Yards on Play Outcomes (Grouped by Air Yards)\*\*

- \*\*Objective\*\*: Determine how different ranges of air yards affect the likelihood of a first down or turnover on downs.

- \*\*Analysis\*\*:

- \*\*Air Yard Efficiency\*\*: Compare how successful passes in different air yard categories are in converting a first down. For example, do passes with air yards between 3-7 have a higher success rate than those over 7?

- \*\*Play-Calling Insights\*\*: Identify optimal air yard ranges for passing plays based on success rates, informing future play-calling strategies.

### 7. \*\*Detailed Yardage-Based Play Calling (Money Down Data)\*\*

- \*\*Objective\*\*: Dive deeper into how specific yardage situations (e.g., 2nd and 2, 3rd and 3) affect play-calling and success rates.

- \*\*Analysis\*\*:

- \*\*Optimal Yardage to Pass/Run\*\*: Identify which yardage situations are best suited for passing versus running, based on historical success.

- \*\*Conversion Efficiency\*\*: Find out if specific yardage situations lead to consistently high or low conversion rates, guiding play-calling decisions in similar future scenarios.

### 8. \*\*Success Rates by Quarter or Game Situation (If Data Available)\*\*

- \*\*Objective\*\*: Analyze how the timing or situation within the game impacts play-calling and success rates.

- \*\*Analysis\*\*:

- \*\*Late Game vs. Early Game\*\*: Compare how successful teams are on money downs in different quarters or game situations. For example, do teams perform better on 4th down in the 4th quarter compared to earlier in the game?

- \*\*Game Context Analysis\*\*: Insights into whether teams become more aggressive or conservative with passing or running based on the time remaining in the game, the score, etc.

### Conclusion:

These analyses provide deep insights into the effectiveness of play-calling in critical downs, how air yards influence passing success, and how teams can optimize their strategies based on historical trends. You can apply these analyses to make data-driven recommendations for coaching staff, teams, or analysts. Depending on the richness of your dataset (e.g., availability of additional variables like game context or field position), you can perform even more nuanced analyses.

Let me know if you'd like help with a specific analysis or need assistance visualizing any of these!