In [2]:
```python
import pandas as pd
import numpy as np
import re
import string
import nltk
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
from nltk.stem import WordNetLemmatizer
import matplotlib.pyplot as plt
import seaborn as sns
from collections import Counter
import warnings

warnings.filterwarnings('ignore')
plt.style.use('seaborn-v0_8-darkgrid')

print("Downloading required NLTK data...")
nltk.download('punkt', quiet=True)
nltk.download('stopwords', quiet=True)
nltk.download('wordnet', quiet=True)
nltk.download('averaged_perceptron_tagger', quiet=True)
nltk.download('omw-1.4', quiet=True)

print("✅ All libraries imported and NLTK data downloaded successfully!")
```

```
Downloading required NLTK data...
✅ All libraries imported and NLTK data downloaded successfully!
```

In [3]:
```python
data_path = '../data/processed/merged_health_data.csv'

df = pd.read_csv(data_path)

print("="*60)
print("DATA LOADED SUCCESSFULLY")
print("="*60)
print(f"Total Records: {len(df):,}")
print(f"Columns: {list(df.columns)}")
print(f"\nFirst 3 rows:")
print(df[['title', 'text', 'health_category']].head(3))
```

```
============================================================
DATA LOADED SUCCESSFULLY
============================================================
Total Records: 19,080
Columns: ['id', 'title', 'text', 'created_utc', 'score', 'num_comments', 'subre
ddit', 'category', 'health_category', 'source_file']

First 3 rows:
                 title                                               text  \
0  Diabetes and wounds  35. M. I've been a bad diabetic for a while, a...
1        T1D in Movies  Curious, for the movie buffs on the sub, what ...
2              Patches  Hi, I'm caring for someone who has very fragil...

  health_category
0        diabetes
1        diabetes
2        diabetes
```

In [4]:
```python
lemmatizer = WordNetLemmatizer()

stop_words = set(stopwords.words('english'))

custom_stopwords = {
    'im', 'ive', 'dont', 'didnt', 'doesnt', 'isnt', 'arent', 'wasnt', 'werent'
    'hasnt', 'havent', 'hadnt', 'wont', 'wouldnt', 'couldnt', 'shouldnt',
    'cant', 'cannot', 'mightnt', 'mustnt', 'shant', 'shan',
    'id', 'youre', 'youve', 'youll', 'youd', 'hes', 'shes', 'its',
    'were', 'theyve', 'theyll', 'theyd', 'whats', 'wheres', 'whens',
    'whos', 'whys', 'hows', 'theres', 'heres',
    'reddit', 'post', 'edit', 'update', 'tldr', 'amp', 'x200b'
}

stop_words.update(custom_stopwords)

print("✅ Preprocessing tools initialized!")
print(f"Total stopwords: {len(stop_words)}")
```

```
✅ Preprocessing tools initialized!
Total stopwords: 244
```

In [5]:
```python
def clean_text(text):
    if pd.isna(text) or text == '':
        return ''

    text = str(text).lower()

    text = re.sub(r'\[deleted\]|\[removed\]', '', text)

    text = re.sub(r'http\S+|www\S+|https\S+', '', text, flags=re.MULTILINE)

    text = re.sub(r'@\w+', '', text)

    text = re.sub(r'#\w+', '', text)
    text = re.sub(r'\n', ' ', text)
    text = re.sub(r'\t', ' ', text)
    text = re.sub(r'\r', ' ', text)

    text = re.sub(r'&amp;|&lt;|&gt;|&quot;', '', text)

    text = re.sub(r'\d+', '', text)

    text = text.translate(str.maketrans('', '', string.punctuation))

    text = re.sub(r'\s+', ' ', text).strip()

    return text

def tokenize_text(text):
    if text == '':
        return []

    try:
        tokens = word_tokenize(text)
    except:
        tokens = text.split()

    return tokens

def remove_stopwords(tokens):
    filtered_tokens = [word for word in tokens if word not in stop_words and l
    return filtered_tokens

def lemmatize_tokens(tokens):
    lemmatized = [lemmatizer.lemmatize(word) for word in tokens]
    return lemmatized

def preprocess_text(text):
    cleaned = clean_text(text)

    tokens = tokenize_text(cleaned)

    tokens = remove_stopwords(tokens)

    tokens = lemmatize_tokens(tokens)

    processed_text = ' '.join(tokens)

    return processed_text

print("✅ Text cleaning functions defined!")
print("\nTesting on sample text:")
sample = "I'm really struggling with my diabetes! Check out this link: https:/
print(f"Original: {sample}")
print(f"Cleaned: {preprocess_text(sample)}")
```

```
✅ Text cleaning functions defined!

Testing on sample text:
Original: I'm really struggling with my diabetes! Check out this link: http
s://example.com #health @doctor123
Cleaned: really struggling diabetes check link
```

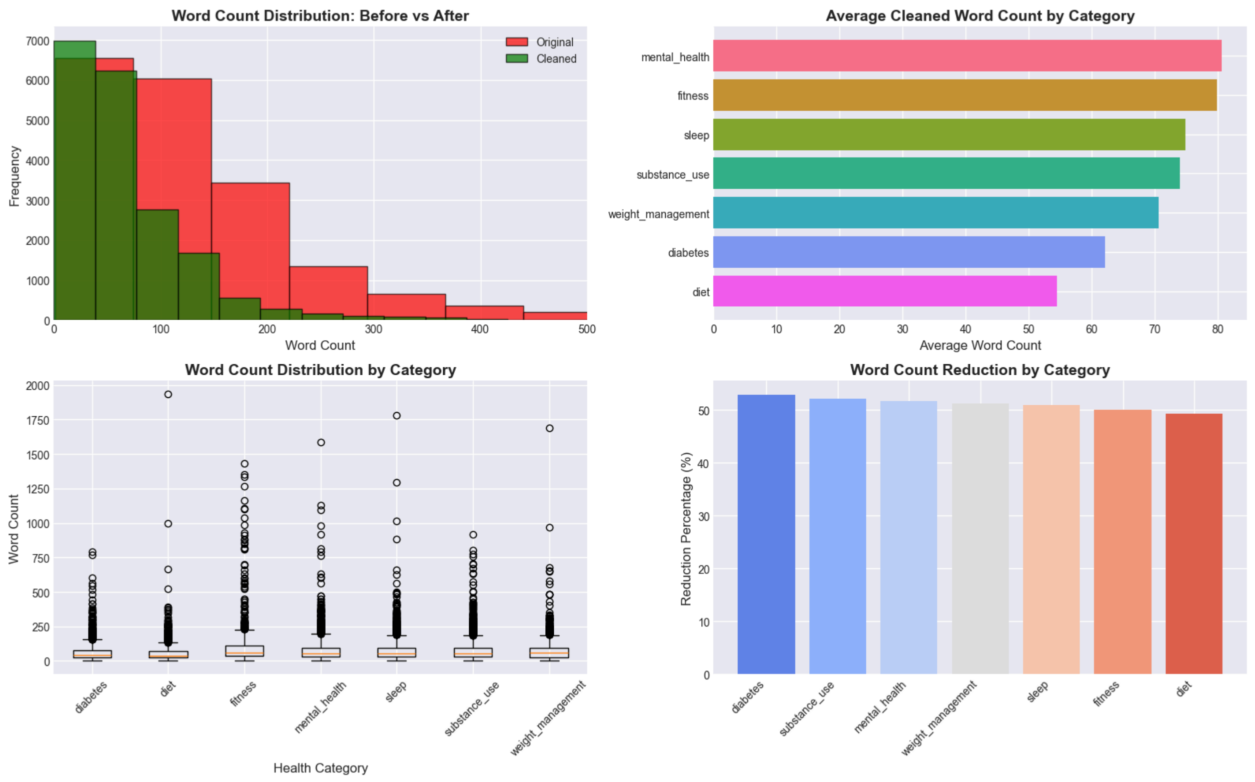
In [6]:
```python
print("="*60)
print("STARTING TEXT PREPROCESSING")
print("="*60)
print("This may take several minutes for large datasets...")
print()

df['cleaned_text'] = df['text'].apply(preprocess_text)

df['cleaned_title'] = df['title'].apply(preprocess_text)

df['combined_text'] = df['cleaned_title'] + ' ' + df['cleaned_text']

df['combined_text'] = df['combined_text'].str.strip()

print("✅ Preprocessing completed!")
print(f"\nSample of cleaned data:")
print("-" * 60)

for idx in df.sample(3).index:
    print(f"\nOriginal: {df.loc[idx, 'text'][:150]}...")
    print(f"Cleaned:  {df.loc[idx, 'cleaned_text'][:150]}...")
    print("-" * 60)
```

```
============================================================
STARTING TEXT PREPROCESSING
============================================================
This may take several minutes for large datasets...

✅ Preprocessing completed!

Sample of cleaned data:
------------------------------------------------------------

Original: raw shredded beets, shredded carrots, grilled chicken, cottage chees
e, red onions, sautéed bell peppers & broccoli, baked sweet potato. drizzle of
pom...
Cleaned:  raw shredded beet shredded carrot grilled chicken cottage cheese red
onion sautéed bell pepper broccoli baked sweet potato drizzle pomegranate molas
se...
------------------------------------------------------------

Original: What are my options for addressing my narrow airway while I am awake?
I have issues breathing and doing things like cardio because of my narrow airwa
y...
Cleaned:  option addressing narrow airway awake issue breathing thing like card
io narrow airway nice addressed sleeping like address waking hour...
------------------------------------------------------------

Original: My personal go to tip if experiencing panic attacks or feel it starti
ng is to go to the bathroom sink and run cold water over hands and face or get
in...
Cleaned:  personal tip experiencing panic attack feel starting bathroom sink ru
n cold water hand face get freezing cold shower minute help shock brain back re
al...
------------------------------------------------------------
```

In [7]:
```python
print("="*60)
print("POST-PREPROCESSING STATISTICS")
print("="*60)

df['cleaned_length'] = df['cleaned_text'].apply(len)
df['cleaned_word_count'] = df['cleaned_text'].apply(lambda x: len(x.split()))

df['original_length'] = df['text'].fillna('').astype(str).apply(len)
df['original_word_count'] = df['text'].fillna('').astype(str).apply(lambda x:

print(f"\nOriginal Data:")
print(f"  Average text length: {df['original_length'].mean():.0f} characters")
print(f"  Average word count: {df['original_word_count'].mean():.0f} words")

print(f"\nCleaned Data:")
print(f"  Average text length: {df['cleaned_length'].mean():.0f} characters")
print(f"  Average word count: {df['cleaned_word_count'].mean():.0f} words")

reduction_chars = ((df['original_length'].mean() - df['cleaned_length'].mean()
reduction_words = ((df['original_word_count'].mean() - df['cleaned_word_count'
print(f"\nReduction:")
print(f"  Characters: {reduction_chars:.1f}%")
print(f"  Words: {reduction_words:.1f}%")

empty_after_cleaning = len(df[df['cleaned_text'] == ''])
print(f"\nEmpty texts after cleaning: {empty_after_cleaning} ({empty_after_cle
```

```
============================================================
POST-PREPROCESSING STATISTICS
============================================================

Original Data:
  Average text length: 812 characters
  Average word count: 145 words

Cleaned Data:
  Average text length: 477 characters
  Average word count: 71 words

Reduction:
  Characters: 41.3%
  Words: 51.2%

Empty texts after cleaning: 16 (0.08%)
```

In [8]:
```
fig, axes = plt.subplots(2, 2, figsize=(16, 10))

axes[0, 0].hist(df['original_word_count'], bins=50, alpha=0.7, color='red', la
axes[0, 0].hist(df['cleaned_word_count'], bins=50, alpha=0.7, color='green', l
axes[0, 0].set_xlabel('Word Count', fontsize=12)
axes[0, 0].set_ylabel('Frequency', fontsize=12)
axes[0, 0].set_title('Word Count Distribution: Before vs After', fontsize=14,
axes[0, 0].legend()
axes[0, 0].set_xlim(0, 500)

word_count_by_category = df.groupby('health_category')['cleaned_word_count'].m
axes[0, 1].barh(range(len(word_count_by_category)), word_count_by_category.val
               color=sns.color_palette("husl", len(word_count_by_category)))
axes[0, 1].set_yticks(range(len(word_count_by_category)))
axes[0, 1].set_yticklabels(word_count_by_category.index)
axes[0, 1].set_xlabel('Average Word Count', fontsize=12)
axes[0, 1].set_title('Average Cleaned Word Count by Category', fontsize=14, fo
axes[0, 1].invert_yaxis()

df_non_empty = df[df['cleaned_text'] != '']
axes[1, 0].boxplot([df_non_empty[df_non_empty['health_category'] == cat]['clea
                    for cat in df['health_category'].unique()],
                   labels=df['health_category'].unique())
axes[1, 0].set_xlabel('Health Category', fontsize=12)
axes[1, 0].set_ylabel('Word Count', fontsize=12)
axes[1, 0].set_title('Word Count Distribution by Category', fontsize=14, fontw
axes[1, 0].tick_params(axis='x', rotation=45)

reduction_per_category = df.groupby('health_category').apply(
    lambda x: ((x['original_word_count'].mean() - x['cleaned_word_count'].mear
).sort_values(ascending=False)

axes[1, 1].bar(range(len(reduction_per_category)), reduction_per_category.valu
              color=sns.color_palette("coolwarm", len(reduction_per_category))
axes[1, 1].set_xticks(range(len(reduction_per_category)))
axes[1, 1].set_xticklabels(reduction_per_category.index, rotation=45, ha='righ
axes[1, 1].set_ylabel('Reduction Percentage (%)', fontsize=12)
axes[1, 1].set_title('Word Count Reduction by Category', fontsize=14, fontweig

plt.tight_layout()
plt.savefig('../reports/preprocessing_impact.png', dpi=300, bbox_inches='tight
plt.show()

print("✅ Visualization saved to: reports/preprocessing_impact.png")
```



```
✅ Visualization saved to: reports/preprocessing_impact.png
```

In [9]:
```
print("="*60)
print("VOCABULARY ANALYSIS")
print("="*60)

all_words = []
for text in df['cleaned_text']:
    if text != '':
        all_words.extend(text.split())

word_freq = Counter(all_words)
total_words = len(all_words)
unique_words = len(word_freq)
```

```
print(f"\nTotal words (after cleaning): {total_words:,}")
print(f"Unique words (vocabulary size): {unique_words:,}")
print(f"Average word frequency: {total_words/unique_words:.2f}")

print(f"\nTop 30 most common words:")
print("-" * 60)
for word, count in word_freq.most_common(30):
    percentage = (count / total_words) * 100
    print(f"{word:20s}: {count:6,} ({percentage:5.2f}%)")
```

```
============================================================
VOCABULARY ANALYSIS
============================================================

Total words (after cleaning): 1,354,316
Unique words (vocabulary size): 40,800
Average word frequency: 33.19

Top 30 most common words:
------------------------------------------------------------
like                : 14,111 ( 1.04%)
day                 : 12,821 ( 0.95%)
i’m                 : 10,992 ( 0.81%)
time                :  9,947 ( 0.73%)
get                 :  9,568 ( 0.71%)
feel                :  8,858 ( 0.65%)
sleep               :  8,198 ( 0.61%)
year                :  7,626 ( 0.56%)
know                :  7,278 ( 0.54%)
also                :  6,952 ( 0.51%)
question            :  6,553 ( 0.48%)
week                :  6,320 ( 0.47%)
would               :  6,222 ( 0.46%)
one                 :  6,199 ( 0.46%)
really              :  5,856 ( 0.43%)
i’ve                :  5,567 ( 0.41%)
thing               :  5,528 ( 0.41%)
want                :  5,473 ( 0.40%)
even                :  5,225 ( 0.39%)
make                :  5,160 ( 0.38%)
back                :  5,087 ( 0.38%)
month               :  4,864 ( 0.36%)
it’s                :  4,848 ( 0.36%)
anyone              :  4,791 ( 0.35%)
still               :  4,786 ( 0.35%)
help                :  4,672 ( 0.34%)
much                :  4,654 ( 0.34%)
work                :  4,567 ( 0.34%)
weight              :  4,450 ( 0.33%)
good                :  4,244 ( 0.31%)
```

In [10]:

```
print("="*60)
print("VOCABULARY ANALYSIS BY CATEGORY")
print("="*60)
```

```
category_vocab = {}

for category in df['health_category'].unique():
    category_text = ' '.join(df[df['health_category'] == category]['cleaned_te
    words = category_text.split()
    category_vocab[category] = {
        'total_words': len(words),
        'unique_words': len(set(words)),
        'top_words': Counter(words).most_common(10)
    }

for category, stats in category_vocab.items():
    print(f"\n{category.upper()}:")
    print(f"  Total words: {stats['total_words']:,}")
    print(f"  Unique words: {stats['unique_words']:,}")
    print(f"  Vocabulary richness: {stats['unique_words']/stats['total_words']
    print(f"  Top 10 words:")
    for word, count in stats['top_words']:
        print(f"    {word:15s}: {count:5,}")
```

```
============================================================
VOCABULARY ANALYSIS BY CATEGORY
============================================================

DIABETES:
  Total words: 157,389
  Unique words: 12,104
  Vocabulary richness: 7.69%
  Top 10 words:
    like           : 1,388
    sugar          : 1,322
    i’m            : 1,310
    day            : 1,253
    blood          : 1,077
    insulin        : 1,060
    get            : 1,059
    year           :   999
    time           :   998
    know           :   969

DIET:
  Total words: 156,558
  Unique words: 12,297
  Vocabulary richness: 7.85%
  Top 10 words:
    like           : 1,605
    keto           : 1,598
    day            : 1,315
    food           : 1,163
    eat            : 1,153
    i’m            : 1,102
    protein        :   966
    time           :   861
    meal           :   849
    get            :   847

FITNESS:
  Total words: 231,052
  Unique words: 10,448
  Vocabulary richness: 4.52%
  Top 10 words:
    question       : 5,422
    thread         : 2,628
    like           : 2,267
    also           : 2,243
    search         : 2,074
    rfitness       : 2,000
    sure           : 1,927
    get            : 1,637
    training       : 1,483
    fitness        : 1,408

MENTAL_HEALTH:
  Total words: 218,914
  Unique words: 14,278
  Vocabulary richness: 6.52%
  Top 10 words:
    pain           : 2,938
    like           : 2,403
    i’m            : 1,922
    migraine       : 1,894
    get            : 1,731
    day            : 1,645
    feel           : 1,629
    anxiety        : 1,535
    time           : 1,429
    know           : 1,285

SLEEP:
  Total words: 207,248
  Unique words: 13,591
  Vocabulary richness: 6.56%
  Top 10 words:
    sleep          : 6,914
    like           : 2,492
    night          : 2,452
    i’m            : 1,852
    get            : 1,780
    feel           : 1,764
    time           : 1,727
    hour           : 1,694
    day            : 1,665
    asleep         : 1,329

SUBSTANCE_USE:
  Total words: 204,854
  Unique words: 13,418
  Vocabulary richness: 6.55%
  Top 10 words:
    day            : 3,412
    i’m            : 2,302
    like           : 2,250
    time           : 2,246
    feel           : 2,222
    year           : 2,120
    get            : 1,442
    smoking        : 1,415
    quit           : 1,368
    know           : 1,309

WEIGHT_MANAGEMENT:
  Total words: 178,301
  Unique words: 11,557
  Vocabulary richness: 6.48%
  Top 10 words:
    weight         : 2,411
    day            : 2,202
    i’m            : 1,788
```

```
   like           : 1,706
   calorie        : 1,662
   time           : 1,303
   eat            : 1,175
   week           : 1,153
   eating         : 1,144
   feel           : 1,088
```

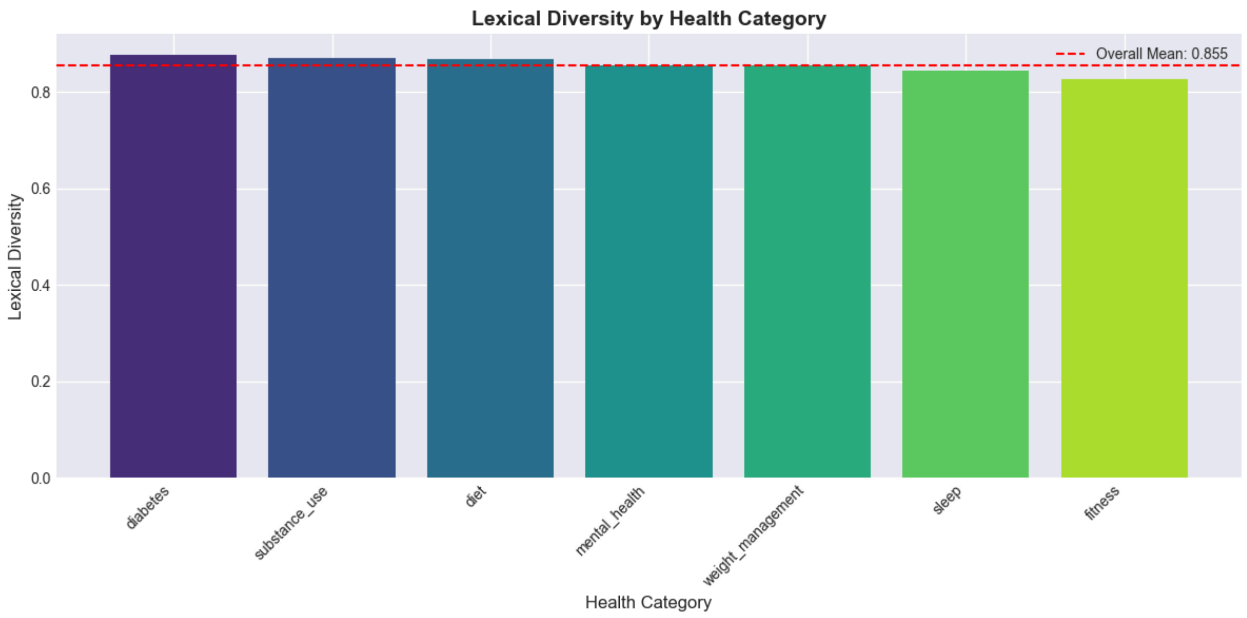
In [11]:
```python
print("="*60)
print("FINAL DATA CLEANING")
print("="*60)

original_count = len(df)

df_clean = df[df['cleaned_text'] != ''].copy()

df_clean = df_clean[df_clean['cleaned_word_count'] >= 3].copy()

removed_count = original_count - len(df_clean)

print(f"Original dataset: {original_count:,} records")
print(f"After removing empty/short texts: {len(df_clean):,} records")
print(f"Removed: {removed_count:,} records ({removed_count/original_count*100:

print(f"\nFinal dataset distribution:")
print(df_clean['health_category'].value_counts())
```

```
============================================================
FINAL DATA CLEANING
============================================================
Original dataset: 19,080 records
After removing empty/short texts: 19,060 records
Removed: 20 records (0.10%)

Final dataset distribution:
health_category
fitness              2892
diet                 2874
sleep                2766
substance_use        2763
mental_health        2715
diabetes             2531
weight_management    2519
Name: count, dtype: int64
```

In [12]:
```python
print("="*60)
print("TEXT QUALITY METRICS")
print("="*60)

def calculate_lexical_diversity(text):
    words = text.split()
    if len(words) == 0:
        return 0
    return len(set(words)) / len(words)
```

```python
df_clean['lexical_diversity'] = df_clean['cleaned_text'].apply(calculate_lexic

print(f"\nLexical Diversity Statistics:")
print(f"  Mean: {df_clean['lexical_diversity'].mean():.3f}")
print(f"  Median: {df_clean['lexical_diversity'].median():.3f}")
print(f"  Std Dev: {df_clean['lexical_diversity'].std():.3f}")

print(f"\nBy Category:")
diversity_by_category = df_clean.groupby('health_category')['lexical_diversity
for category, diversity in diversity_by_category.items():
    print(f"  {category:25s}: {diversity:.3f}")

plt.figure(figsize=(12, 6))
plt.bar(range(len(diversity_by_category)), diversity_by_category.values,
       color=sns.color_palette("viridis", len(diversity_by_category)))
plt.xticks(range(len(diversity_by_category)), diversity_by_category.index, rot
plt.ylabel('Lexical Diversity', fontsize=12)
plt.xlabel('Health Category', fontsize=12)
plt.title('Lexical Diversity by Health Category', fontsize=14, fontweight='bol
plt.axhline(y=df_clean['lexical_diversity'].mean(), color='red', linestyle='--
           label=f'Overall Mean: {df_clean["lexical_diversity"].mean():.3f}')
plt.legend()
plt.tight_layout()
plt.savefig('../reports/lexical_diversity.png', dpi=300, bbox_inches='tight')
plt.show()

print("\n✅ Visualization saved to: reports/lexical_diversity.png")
```

```
============================================================
TEXT QUALITY METRICS
============================================================

Lexical Diversity Statistics:
  Mean: 0.855
  Median: 0.857
  Std Dev: 0.094

By Category:
  diabetes                 : 0.876
  substance_use            : 0.869
  diet                     : 0.869
  mental_health            : 0.855
  weight_management        : 0.854
  sleep                    : 0.843
  fitness                  : 0.825
```



```
✅ Visualization saved to: reports/lexical_diversity.png
```

In [13]:
```python
print("="*60)
print("CREATING ADDITIONAL FEATURES")
print("="*60)

df_clean['text_cleaned_length'] = df_clean['cleaned_text'].apply(len)

df_clean['avg_word_length'] = df_clean['cleaned_text'].apply(
    lambda x: np.mean([len(word) for word in x.split()]) if x else 0
)

df_clean['sentence_count'] = df_clean['text'].fillna('').apply(
    lambda x: len([s for s in re.split(r'[.!?]+', str(x)) if s.strip()])
)

df_clean['has_question'] = df_clean['text'].fillna('').str.contains(r'\?', reg

df_clean['has_exclamation'] = df_clean['text'].fillna('').str.contains(r'!', r

df_clean['uppercase_ratio'] = df_clean['text'].fillna('').apply(
    lambda x: sum(1 for c in str(x) if c.isupper()) / len(str(x)) if len(str(x
)

print("✅ Additional features created!")
print(f"\nNew feature columns:")
feature_cols = ['text_cleaned_length', 'avg_word_length', 'sentence_count',
                'has_question', 'has_exclamation', 'uppercase_ratio', 'lexical
print(feature_cols)

print(f"\nSample statistics:")
print(df_clean[feature_cols].describe())
```

```
============================================================
CREATING ADDITIONAL FEATURES
============================================================
✅ Additional features created!

New feature columns:
['text_cleaned_length', 'avg_word_length', 'sentence_count', 'has_question', 'h
as_exclamation', 'uppercase_ratio', 'lexical_diversity']

Sample statistics:
       text_cleaned_length  avg_word_length  sentence_count  has_question  \
count         19060.000000     19060.000000    19060.000000  19060.000000   
mean            477.367681         5.696428       10.242078      0.602886   
std             545.198123         0.504391       11.469455      0.489313   
min              16.000000         3.750000        1.000000      0.000000   
25%             187.000000         5.362603        4.000000      0.000000   
50%             337.000000         5.655172        7.000000      1.000000   
75%             599.000000         6.000000       12.000000      1.000000   
max           13639.000000         9.666667      224.000000      1.000000   

       has_exclamation  uppercase_ratio  lexical_diversity  
count     19060.000000     19060.000000       19060.000000  
mean          0.261700         0.025792           0.855407  
std           0.439572         0.017342           0.094427  
min           0.000000         0.000000           0.136761  
25%           0.000000         0.017937           0.790698  
50%           0.000000         0.023443           0.857143  
75%           1.000000         0.030534           0.923077  
max           1.000000         0.788732           1.000000  
```

In [14]:
```python
print("="*60)
print("SAVING PREPROCESSED DATA")
print("="*60)

columns_to_save = [
    'id', 'title', 'text', 'cleaned_title', 'cleaned_text', 'combined_text',
    'health_category', 'subreddit', 'score', 'num_comments', 'created_utc',
    'cleaned_word_count', 'text_cleaned_length', 'avg_word_length',
    'sentence_count', 'has_question', 'has_exclamation',
    'uppercase_ratio', 'lexical_diversity'
]

available_columns = [col for col in columns_to_save if col in df_clean.columns

df_output = df_clean[available_columns].copy()

output_path = '../data/processed/preprocessed_data.csv'
df_output.to_csv(output_path, index=False)

print(f"✅ Preprocessed data saved to: {output_path}")
print(f"\nDataset shape: {df_output.shape}")
print(f"Columns saved: {len(available_columns)}")
print(f"\nColumn list:")
for col in available_columns:
    print(f"  - {col}")
```

```
============================================================
SAVING PREPROCESSED DATA
============================================================
✅ Preprocessed data saved to: ../data/processed/preprocessed_data.csv

Dataset shape: (19060, 19)
Columns saved: 19

Column list:
  - id
  - title
  - text
  - cleaned_title
  - cleaned_text
  - combined_text
  - health_category
  - subreddit
  - score
  - num_comments
  - created_utc
  - cleaned_word_count
  - text_cleaned_length
  - avg_word_length
  - sentence_count
  - has_question
  - has_exclamation
  - uppercase_ratio
  - lexical_diversity
```

In [15]:

```
print("="*60)
print("SAVING CATEGORY-WISE DATA FILES")
print("="*60)

category_output_dir = '../data/processed/by_category/'

import os
os.makedirs(category_output_dir, exist_ok=True)

for category in df_clean['health_category'].unique():
    category_df = df_clean[df_clean['health_category'] == category][available_

    category_file = f"{category_output_dir}{category}_preprocessed.csv"
    category_df.to_csv(category_file, index=False)

    print(f"✅ Saved {category}: {len(category_df):,} records → {category_file

print(f"\n✅ All category files saved to: {category_output_dir}")
```

```
============================================================
SAVING CATEGORY-WISE DATA FILES
============================================================
✅ Saved diabetes: 2,531 records → ../data/processed/by_category/diabetes_prepr
ocessed.csv
✅ Saved diet: 2,874 records → ../data/processed/by_category/diet_preprocesse
d.csv
✅ Saved fitness: 2,892 records → ../data/processed/by_category/fitness_preproc
essed.csv
✅ Saved mental_health: 2,715 records → ../data/processed/by_category/mental_he
alth_preprocessed.csv
✅ Saved sleep: 2,766 records → ../data/processed/by_category/sleep_preprocesse
d.csv
✅ Saved substance_use: 2,763 records → ../data/processed/by_category/substanc
e_use_preprocessed.csv
✅ Saved weight_management: 2,519 records → ../data/processed/by_category/weigh
t_management_preprocessed.csv

✅ All category files saved to: ../data/processed/by_category/
```

In [16]:

```python
print("="*80)
print(" " * 25 + "PREPROCESSING SUMMARY REPORT")
print("="*80)

print("\n📊 DATA TRANSFORMATION:")
print("-" * 80)
print(f"  Original dataset: {original_count:,} records")
print(f"  Final dataset: {len(df_clean):,} records")
print(f"  Records removed: {removed_count:,} ({removed_count/original_count*10

print("\n📝 TEXT STATISTICS:")
print("-" * 80)
print(f"  Average cleaned text length: {df_clean['text_cleaned_length'].mean()
print(f"  Average cleaned word count: {df_clean['cleaned_word_count'].mean():.
print(f"  Average word length: {df_clean['avg_word_length'].mean():.2f} charac
print(f"  Average lexical diversity: {df_clean['lexical_diversity'].mean():.3f

print("\n📚 VOCABULARY:")
print("-" * 80)
print(f"  Total words (corpus): {total_words:,}")
print(f"  Unique words (vocabulary): {unique_words:,}")
print(f"  Vocabulary richness: {unique_words/total_words*100:.2f}%")

print("\n📈 CATEGORY DISTRIBUTION (FINAL):")
print("-" * 80)
for category, count in df_clean['health_category'].value_counts().items():
    percentage = (count / len(df_clean)) * 100
    print(f"  {category:25s}: {count:6,} records ({percentage:5.2f}%)")

print("\n💡 FEATURE ENGINEERING:")
print("-" * 80)
print(f"  Features created: {len(feature_cols)}")
print("  Features list:")
for feat in feature_cols:
    print(f"    - {feat}")

print("\n📁 OUTPUT FILES:")
print("-" * 80)
print(f"  ✅ Main file: {output_path}")
print(f"  ✅ Category files: {len(df_clean['health_category'].unique())} files
print(f"  ✅ Visualizations:")
print(f"     - preprocessing_impact.png")
print(f"     - lexical_diversity.png")

print("\n🎯 PREPROCESSING PIPELINE STEPS COMPLETED:")
print("-" * 80)
print("  ✅ Text cleaning (URLs, special chars, punctuation)")
print("  ✅ Tokenization")
print("  ✅ Stopword removal (English + custom)")
print("  ✅ Lemmatization")
print("  ✅ Empty text removal")
print("  ✅ Feature engineering")
print("  ✅ Data validation")
print("  ✅ Category-wise file generation")

print("\n" + "="*80)
print(" " * 25 + "PREPROCESSING COMPLETED SUCCESSFULLY! ✅")
print("="*80)
```

```
================================================================================
=
                         PREPROCESSING SUMMARY REPORT
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=

📊 DATA TRANSFORMATION:
--------------------------------------------------------------------------------
-
  Original dataset: 19,080 records
  Final dataset: 19,060 records
  Records removed: 20 (0.10%)

📝 TEXT STATISTICS:
--------------------------------------------------------------------------------
-
  Average cleaned text length: 477 characters
  Average cleaned word count: 71 words
  Average word length: 5.70 characters
  Average lexical diversity: 0.855

📚 VOCABULARY:
--------------------------------------------------------------------------------
-
  Total words (corpus): 1,354,316
  Unique words (vocabulary): 40,800
  Vocabulary richness: 3.01%

📈 CATEGORY DISTRIBUTION (FINAL):
--------------------------------------------------------------------------------
-
  fitness                   :  2,892 records (15.17%)
  diet                      :  2,874 records (15.08%)
  sleep                     :  2,766 records (14.51%)
  substance_use             :  2,763 records (14.50%)
  mental_health             :  2,715 records (14.24%)
  diabetes                  :  2,531 records (13.28%)
  weight_management         :  2,519 records (13.22%)

💡 FEATURE ENGINEERING:
--------------------------------------------------------------------------------
-
  Features created: 7
  Features list:
    - text_cleaned_length
    - avg_word_length
    - sentence_count
    - has_question
    - has_exclamation
    - uppercase_ratio
    - lexical_diversity

📁 OUTPUT FILES:
--------------------------------------------------------------------------------
```

```
-
  ✅ Main file: ../data/processed/preprocessed_data.csv
  ✅ Category files: 7 files in ../data/processed/by_category/
  ✅ Visualizations:
     - preprocessing_impact.png
     - lexical_diversity.png

🎯 PREPROCESSING PIPELINE STEPS COMPLETED:
--------------------------------------------------------------------------------
-
  ✅ Text cleaning (URLs, special chars, punctuation)
  ✅ Tokenization
  ✅ Stopword removal (English + custom)
  ✅ Lemmatization
  ✅ Empty text removal
  ✅ Feature engineering
  ✅ Data validation
  ✅ Category-wise file generation

================================================================================
=
                         PREPROCESSING COMPLETED SUCCESSFULLY! ✅
================================================================================
=
```

In [17]:
```python
print("="*60)
print("FINAL DATA QUALITY CHECK")
print("="*60)

print("\n✓ Checking for null values in key columns:")
key_columns = ['cleaned_text', 'health_category', 'combined_text']
for col in key_columns:
    null_count = df_clean[col].isnull().sum()
    print(f"  {col}: {null_count} nulls")

print("\n✓ Checking for empty strings:")
empty_cleaned = len(df_clean[df_clean['cleaned_text'] == ''])
empty_combined = len(df_clean[df_clean['combined_text'] == ''])
print(f"  cleaned_text: {empty_cleaned} empty strings")
print(f"  combined_text: {empty_combined} empty strings")

print("\n✓ Checking word count distribution:")
very_short = len(df_clean[df_clean['cleaned_word_count'] < 5])
short = len(df_clean[(df_clean['cleaned_word_count'] >= 5) & (df_clean['cleane
medium = len(df_clean[(df_clean['cleaned_word_count'] >= 20) & (df_clean['clea
long = len(df_clean[df_clean['cleaned_word_count'] >= 100])

print(f"  Very short (<5 words): {very_short:,} ({very_short/len(df_clean)*100
print(f"  Short (5-19 words): {short:,} ({short/len(df_clean)*100:.1f}%)")
print(f"  Medium (20-99 words): {medium:,} ({medium/len(df_clean)*100:.1f}%)")
print(f"  Long (100+ words): {long:,} ({long/len(df_clean)*100:.1f}%)")

print("\n✓ Checking category balance:")
min_category_size = df_clean['health_category'].value_counts().min()
```

```python
max_category_size = df_clean['health_category'].value_counts().max()
balance_ratio = min_category_size / max_category_size
print(f"  Smallest category: {min_category_size:,} samples")
print(f"  Largest category: {max_category_size:,} samples")
print(f"  Balance ratio: {balance_ratio:.3f}")
if balance_ratio < 0.3:
    print(f"  ⚠ Warning: Significant class imbalance detected!")
else:
    print(f"  ✅ Categories are reasonably balanced")

print("\n" + "="*60)
print("DATA QUALITY CHECK COMPLETED! ✅")
print("="*60)
```

```
============================================================
FINAL DATA QUALITY CHECK
============================================================

✓ Checking for null values in key columns:
  cleaned_text: 0 nulls
  health_category: 0 nulls
  combined_text: 0 nulls

✓ Checking for empty strings:
  cleaned_text: 0 empty strings
  combined_text: 0 empty strings

✓ Checking word count distribution:
  Very short (<5 words): 37 (0.2%)
  Short (5-19 words): 2,595 (13.6%)
  Medium (20-99 words): 12,378 (64.9%)
  Long (100+ words): 4,050 (21.2%)

✓ Checking category balance:
  Smallest category: 2,519 samples
  Largest category: 2,892 samples
  Balance ratio: 0.871
  ✅ Categories are reasonably balanced

============================================================
DATA QUALITY CHECK COMPLETED! ✅
============================================================
```

In [ ]: