



Analysis of Impact of Aircraft Age on Safety for Air Transport Jet Airplanes



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Motivation

- **Concern Regarding Impact of Aircraft Age on Aviation Safety Triggered by Key Accidents**
 - Structural - Aloha Airlines 243 (1988)
 - Boeing 737-297
 - In-Flight Explosive Decompression
 - 19 Years Old, 35,486 hours, 89,690 cycles
 - Systems & Electrical -TWA 800 (1996)
 - Boeing 747
 - In-Flight Break-Up, Fuel Tank Explosion, Electrical Ignition
 - 25 Years Old





Response to Aging Aircraft Concerns

- **US National Aging Aircraft Research Program**
 - 1988 Structural Focus
 - Widespread Fatigue Damage (WFD)
 - 1996 Focus Expanded to Include Systems
 - eg Electrical
 - **Airworthiness Assurance Working Group (AAWG)**
 - Manufacturers, Operators, Maintenance Orgs, Regulatory Groups
 - **Improved Maintenance and Monitoring Programs**
 - **Limit of Validity (LOV) Approach for Structures**
 - Flight Cycles or Hours Based
 - **Some States Impose Age Based Restrictions on Imports**
 - Vary from 10-25 Years (Chronological)
 - Unclear if there is a Valid Basis for Age Based Restrictions
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Objective

- **Evaluate if aircraft chronological age is an indicator of safety risk in the commercial air transport jet fleet**
- **Study supported by the Aviation Working Group* as an independent technical analysis of available safety data**

*** Aviation Working Group (AWG) is a not-for-profit entity comprised of major aviation manufactures, leasing companies and financial institutions that contribute to the development of polities, laws, and regulations that facilitate advanced international aviation financing and leasing**



Approach

- **Historical Evaluation of Correlation Between Aircraft Age and Accident Rate**
 - **Data**
 - Flightglobal Ascend Online Database (1959 - 2012)
 - Aircraft Histories
 - Region of Operation
 - Accident Narratives
 - **Limitations**
 - Jet Transport Aircraft (MTOW > 60,000 lbs)
 - Aircraft Manufactured in CIS or Soviet Union not Included Due to Lack of Comprehensive Data
 - Aircraft Types with No Accident History not Included
 - Detailed Operational Use (Cycles or Hours) not Available for All Aircraft
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Aircraft-Year Based Accident Rate Metric

- **Data Was Not Detailed Enough to Use Traditional Accident Rate Metric of Accidents per Aircraft Cycle**
 - **Aircraft-Year Based Metric Defined as the Number of Accidents Which Occurred Divided by the Number of Aircraft-Years of Operation**
 - Implicitly Assumes Each Aircraft-Year has Same Risk Exposure
 - Reasonable Given High Level Scope of Analysis
 - **Inverse of Aircraft-Year Metric is the Average Number of Years Between Accidents.**
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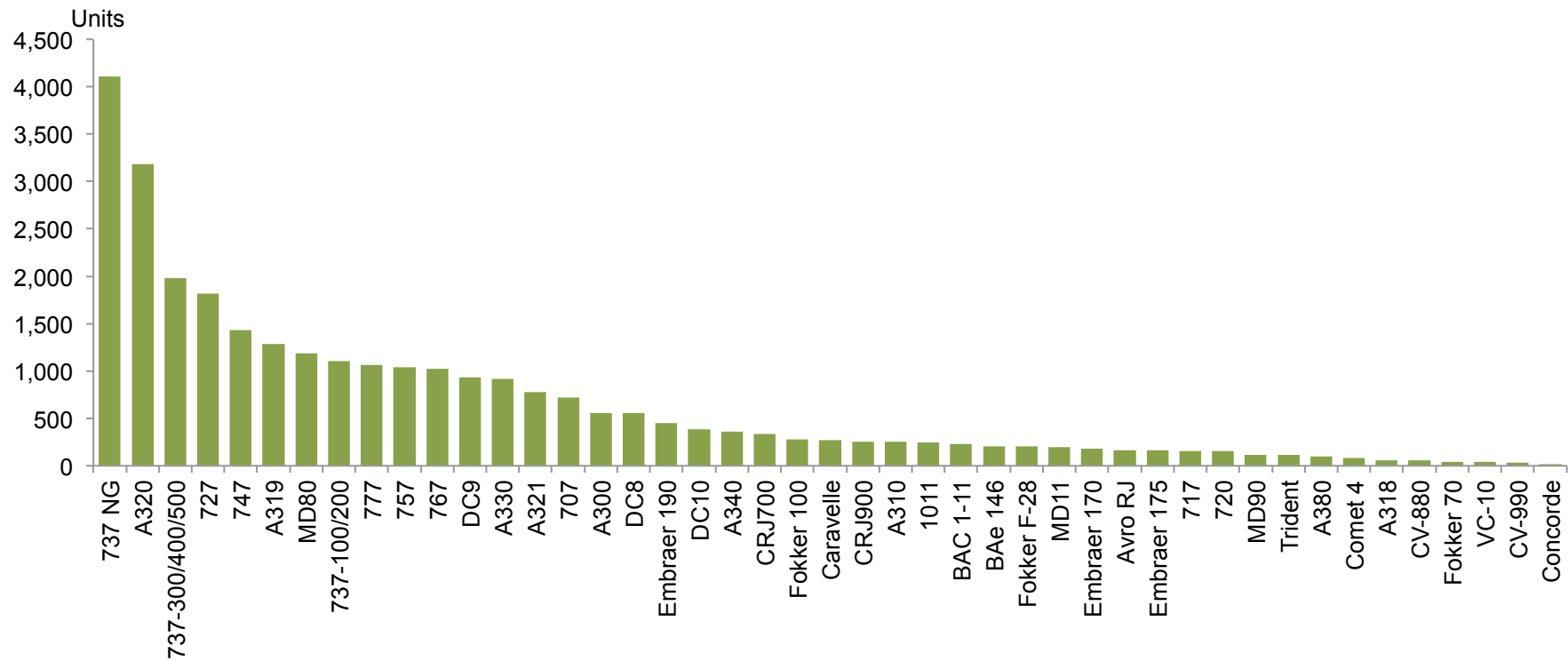


Accident Definition

- **Events Where Aircraft Sustained Substantial Damage, Became Missing or Inaccessible as well as Events where Fatal or Serious Injury Resulted from Being in the Airplane or Direct Contact with the Airplane or it's Jet Blast**
 - **Excluded Events**
 - Sabotage
 - Hijacking
 - Terrorism
 - Military Action
 - Stowaway
 - Non-Fatal Injuries from Turbulence, Loose Objects, or Boarding
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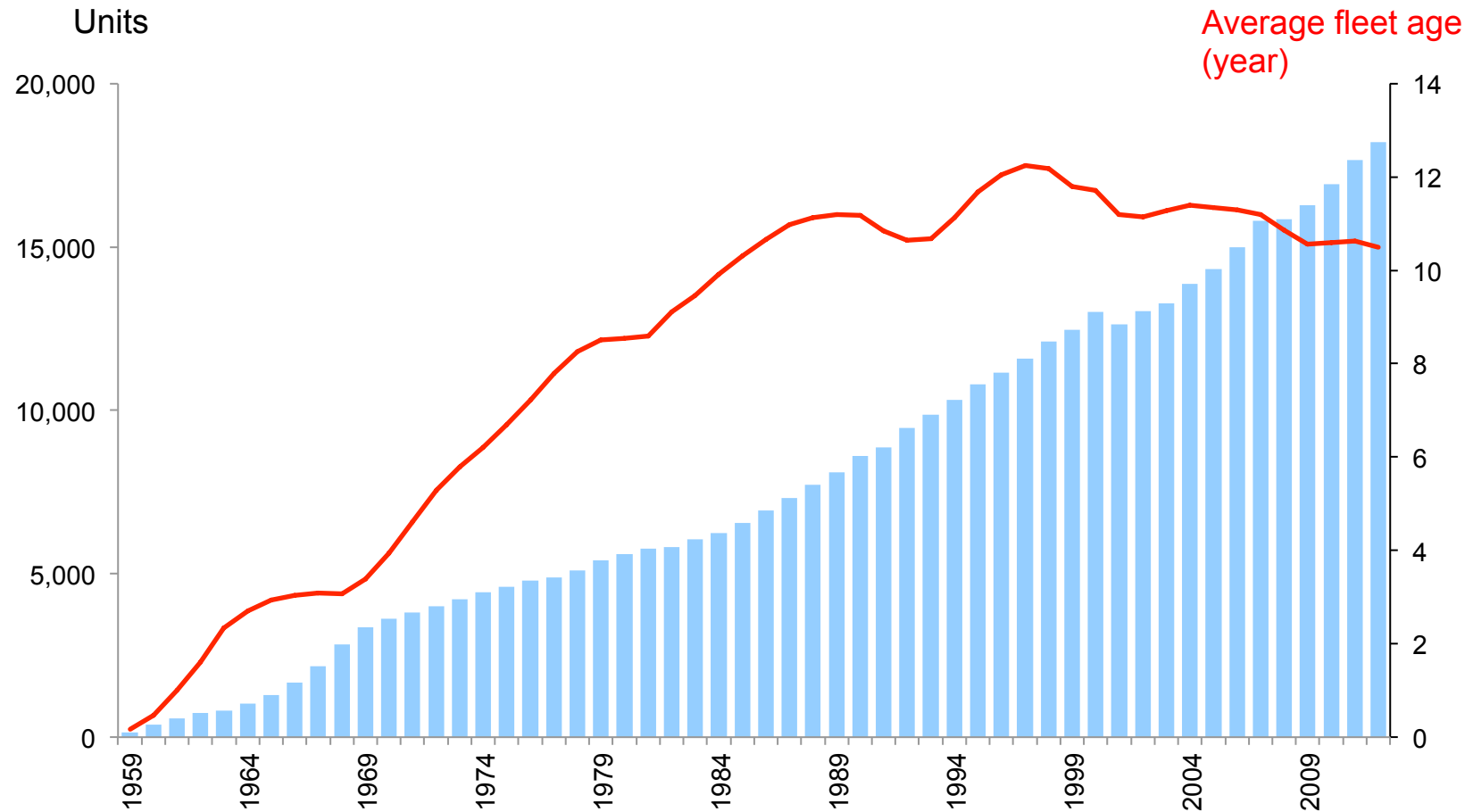


Distribution of Commercial Deliveries by Aircraft Type





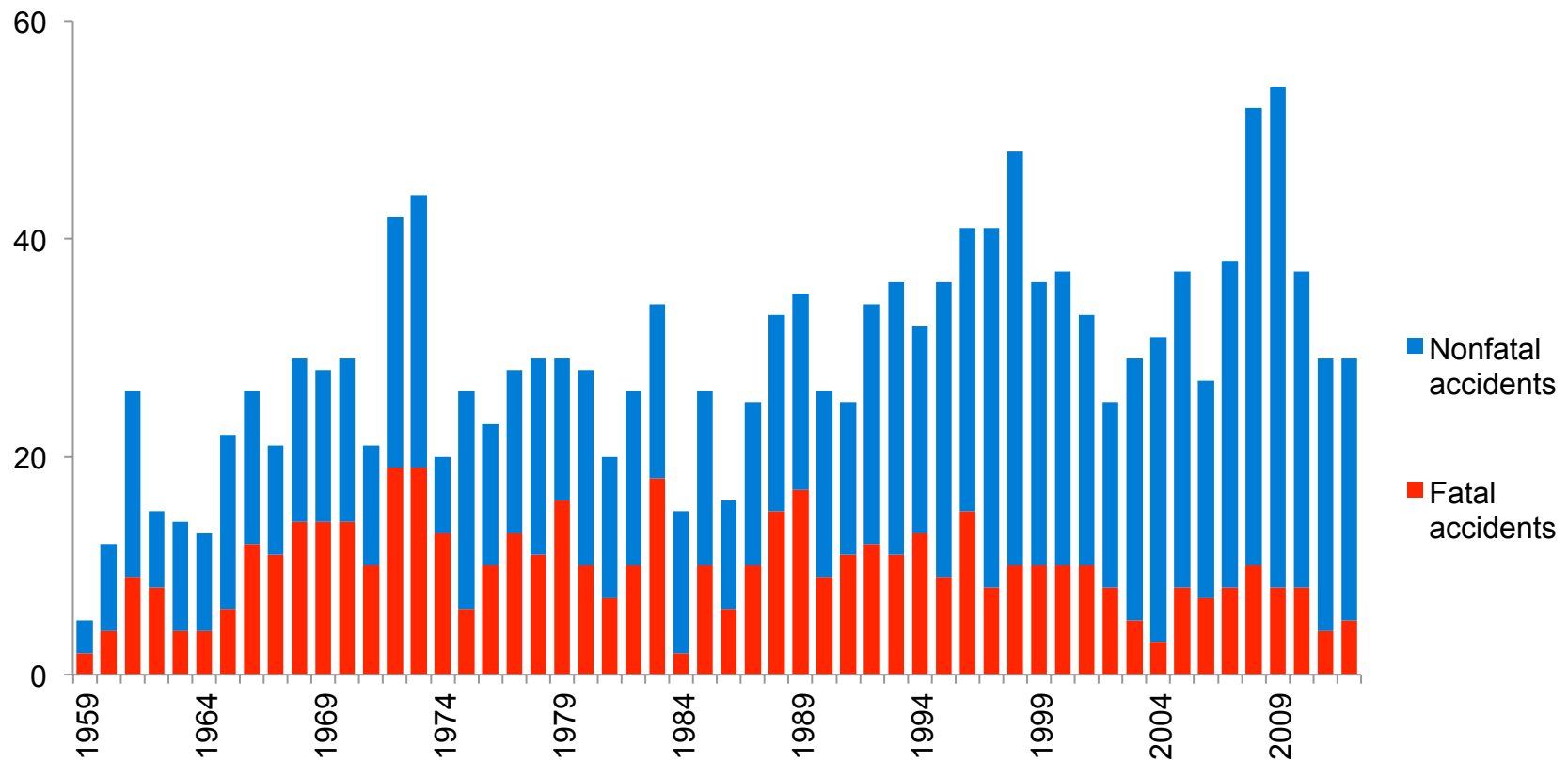
Growth of In-Service Fleet and Average Fleet Age





Annual Number of Accidents by Year

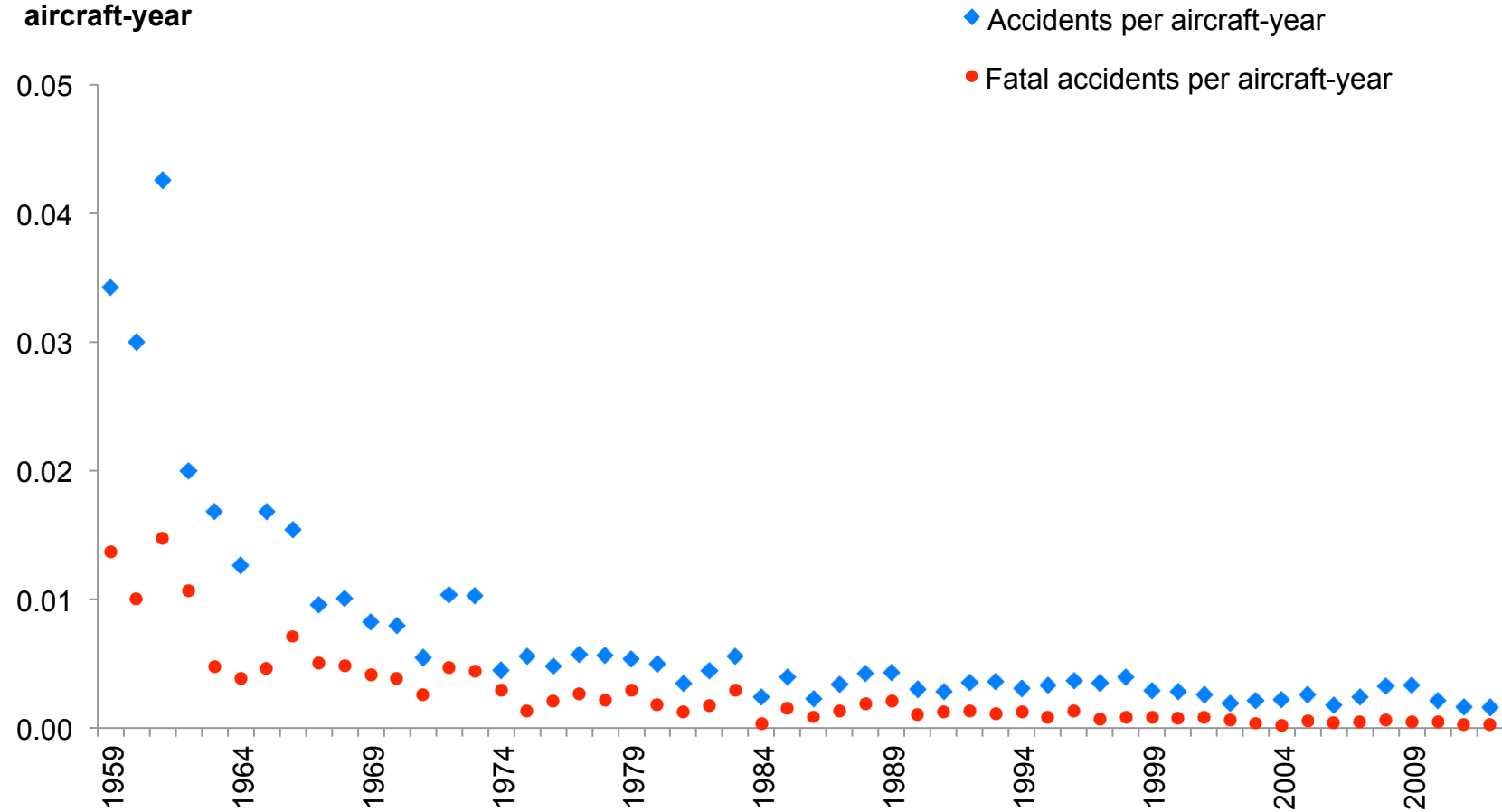
Number of accidents





Accidents per Aircraft-Year vs Time

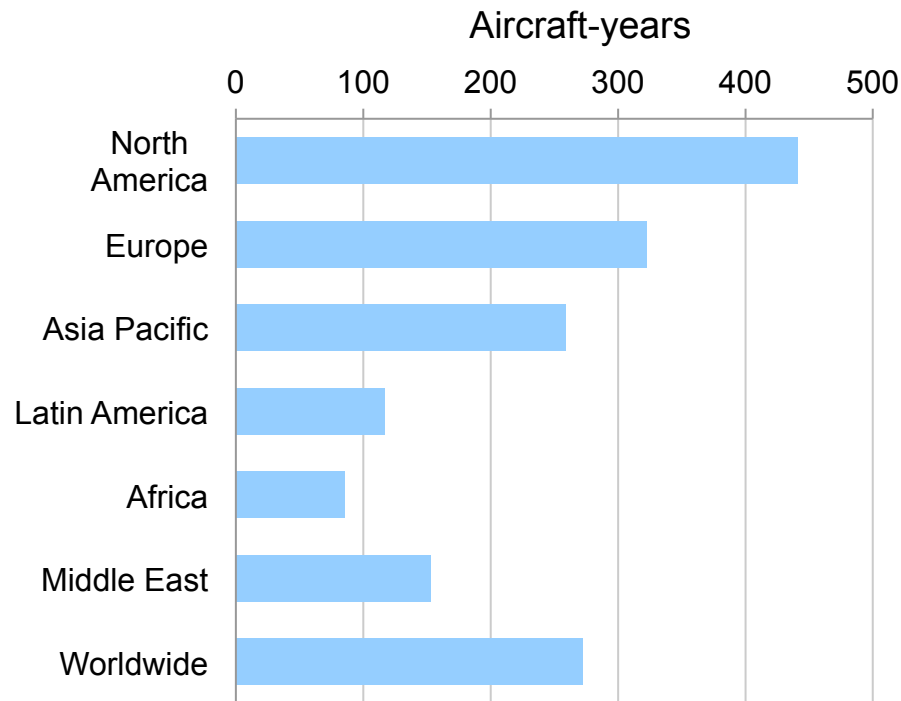
Accidents per
aircraft-year



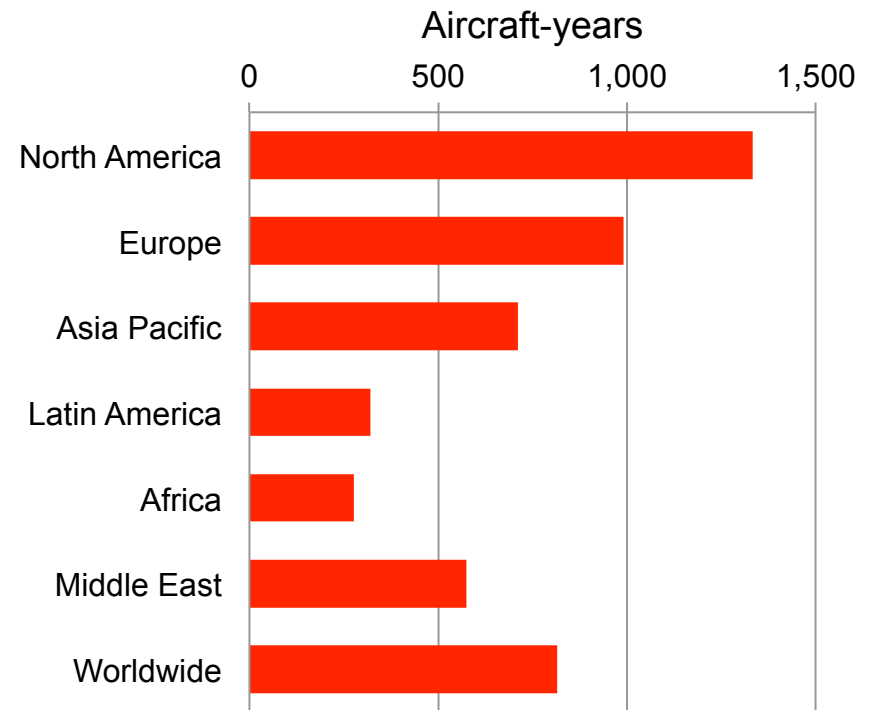


Average Aircraft-Years Between Accidents by World Region

All Accidents

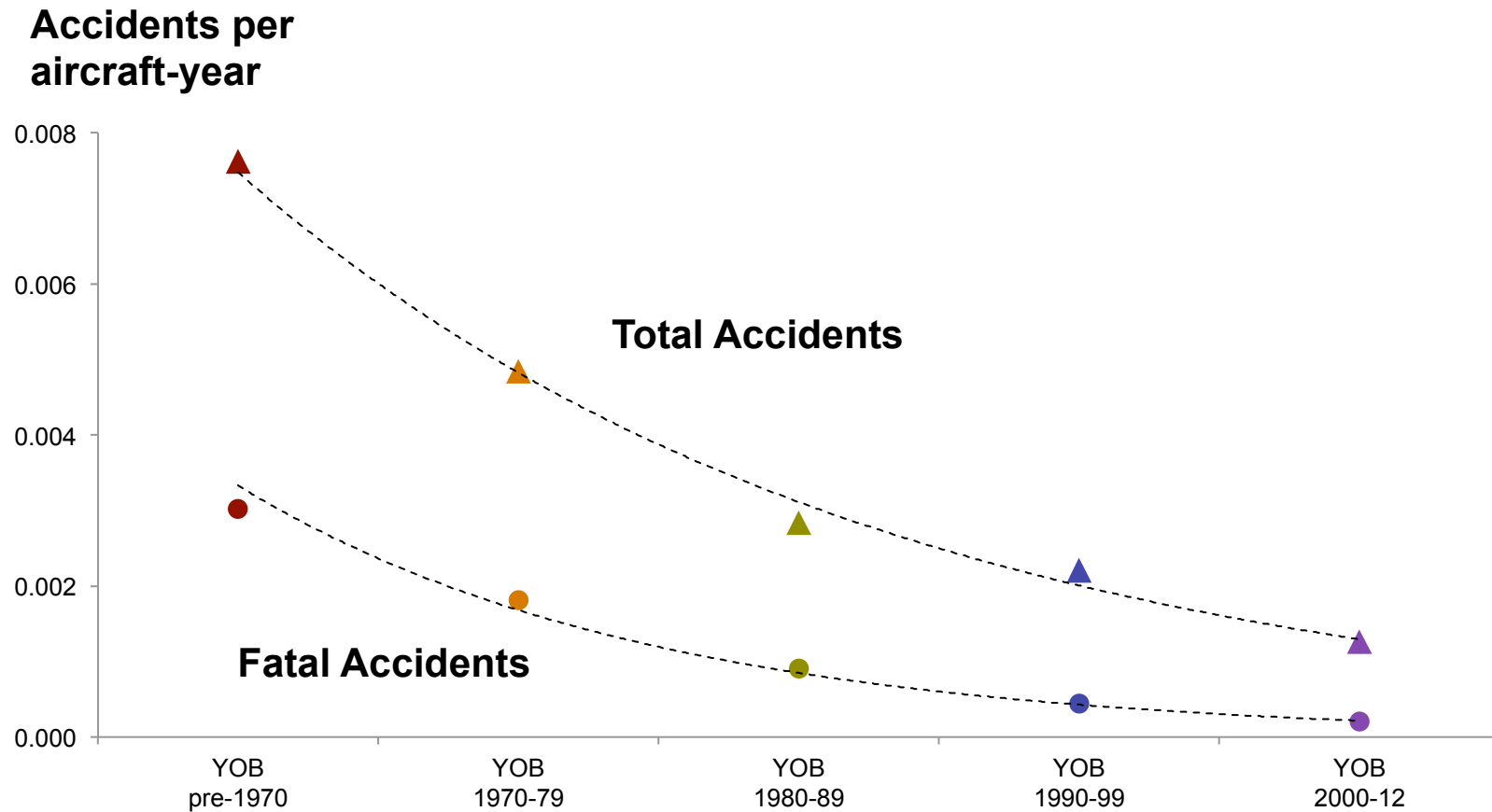


Fatal Accidents



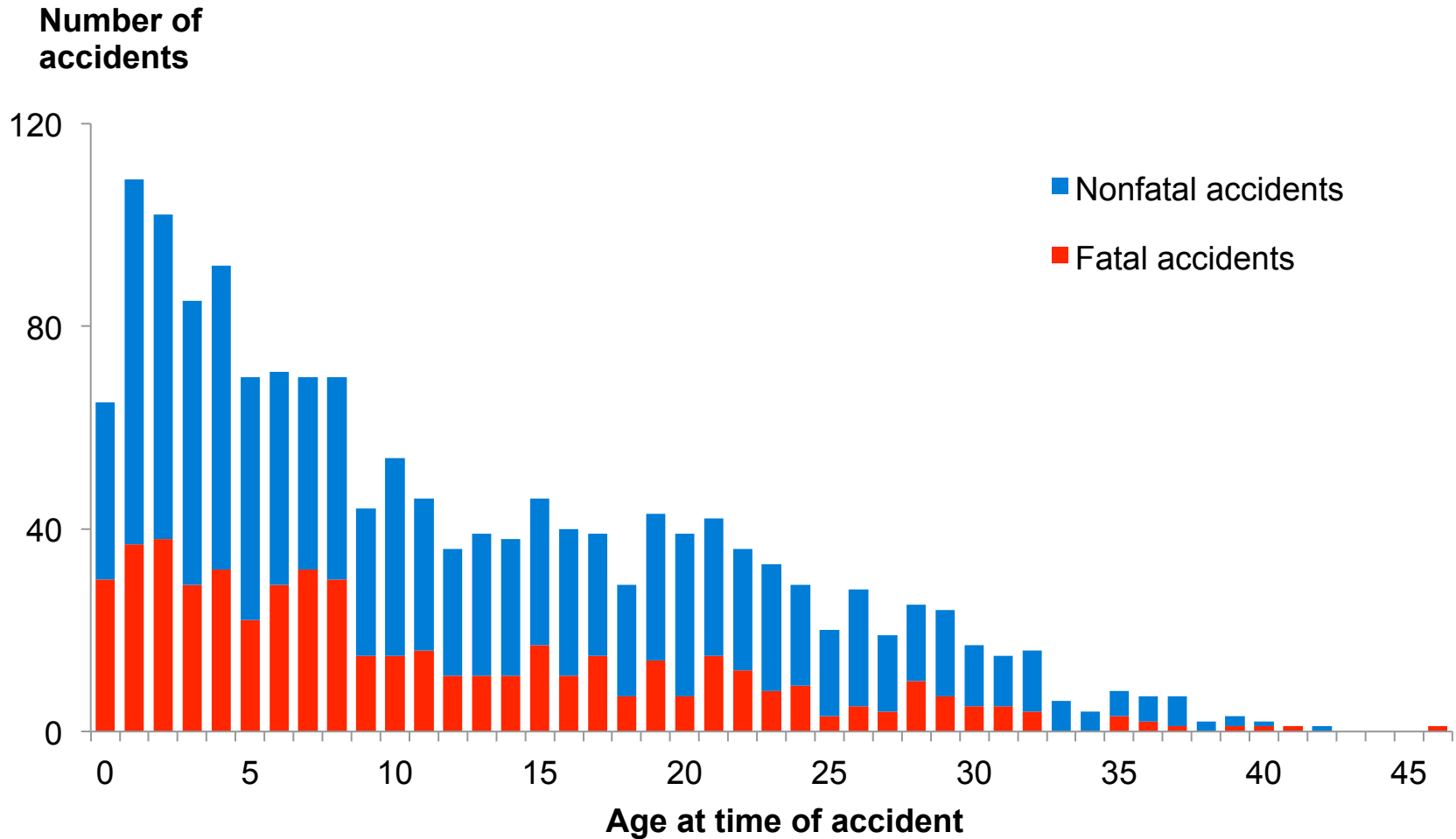


Accident Rate By Year-of-Build Group



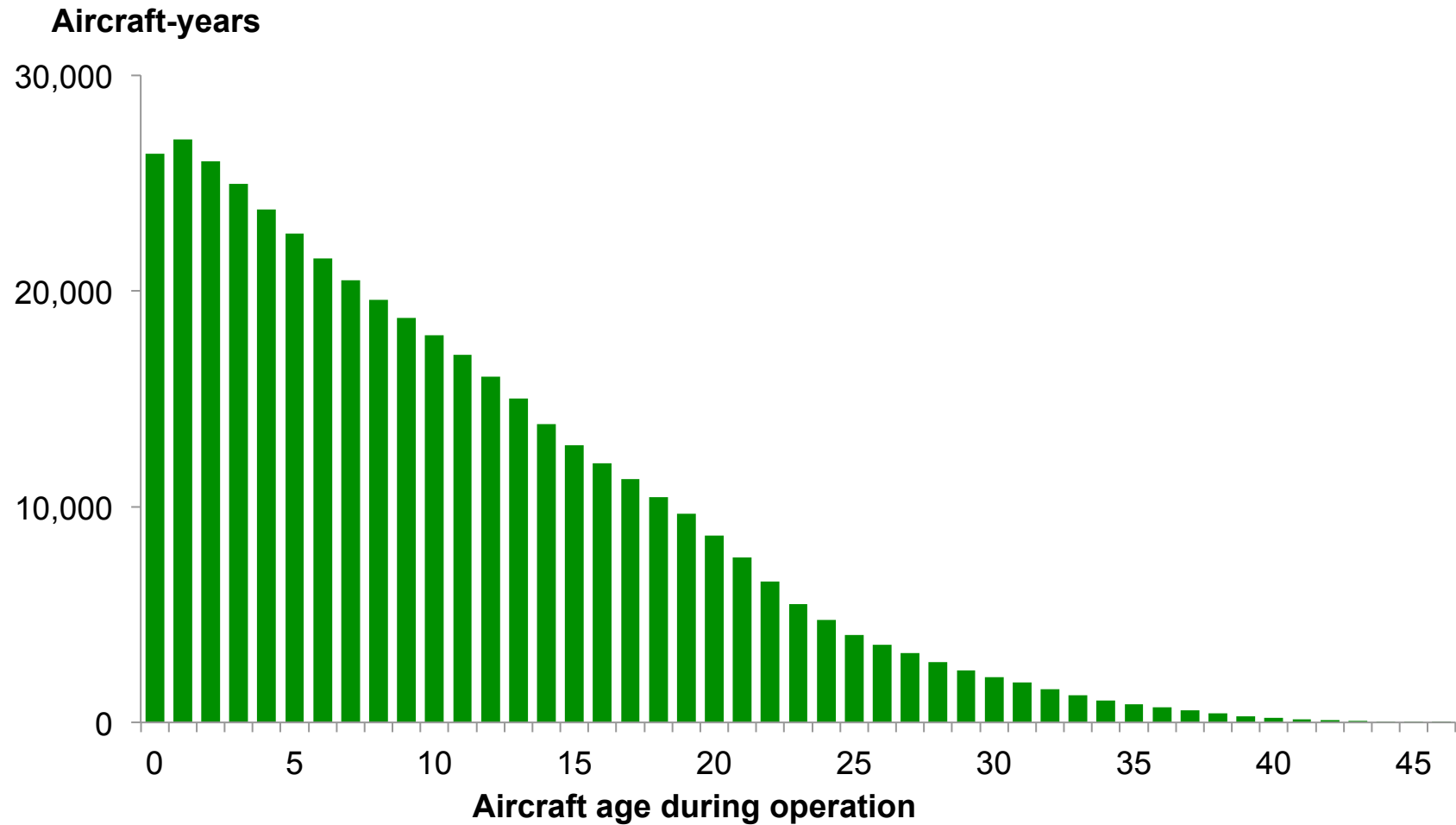


Accidents by Aircraft Age at Time of Accident





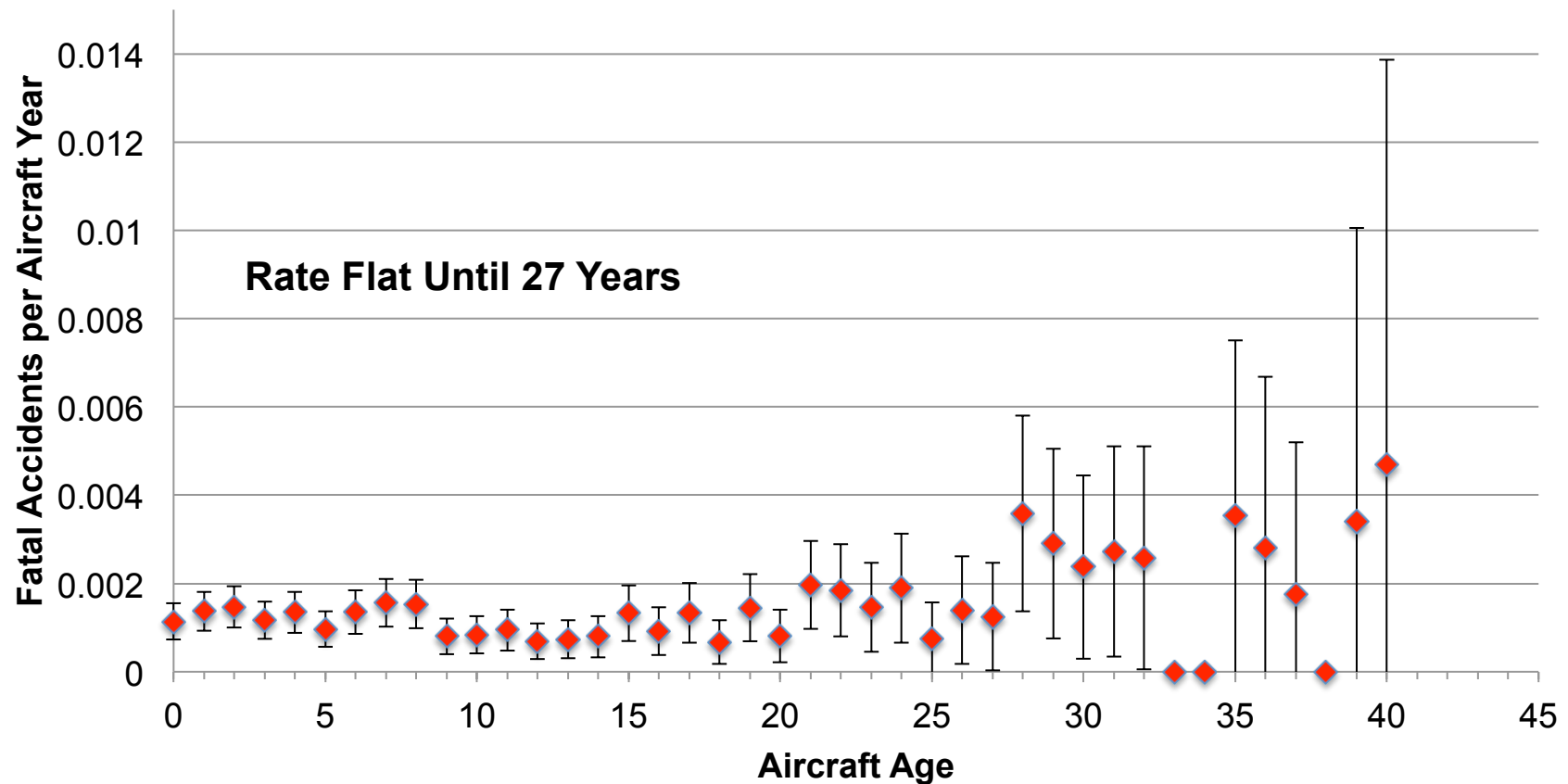
Fleet Exposure by Aircraft Age





Fatal Accident Rate vs Aircraft Age

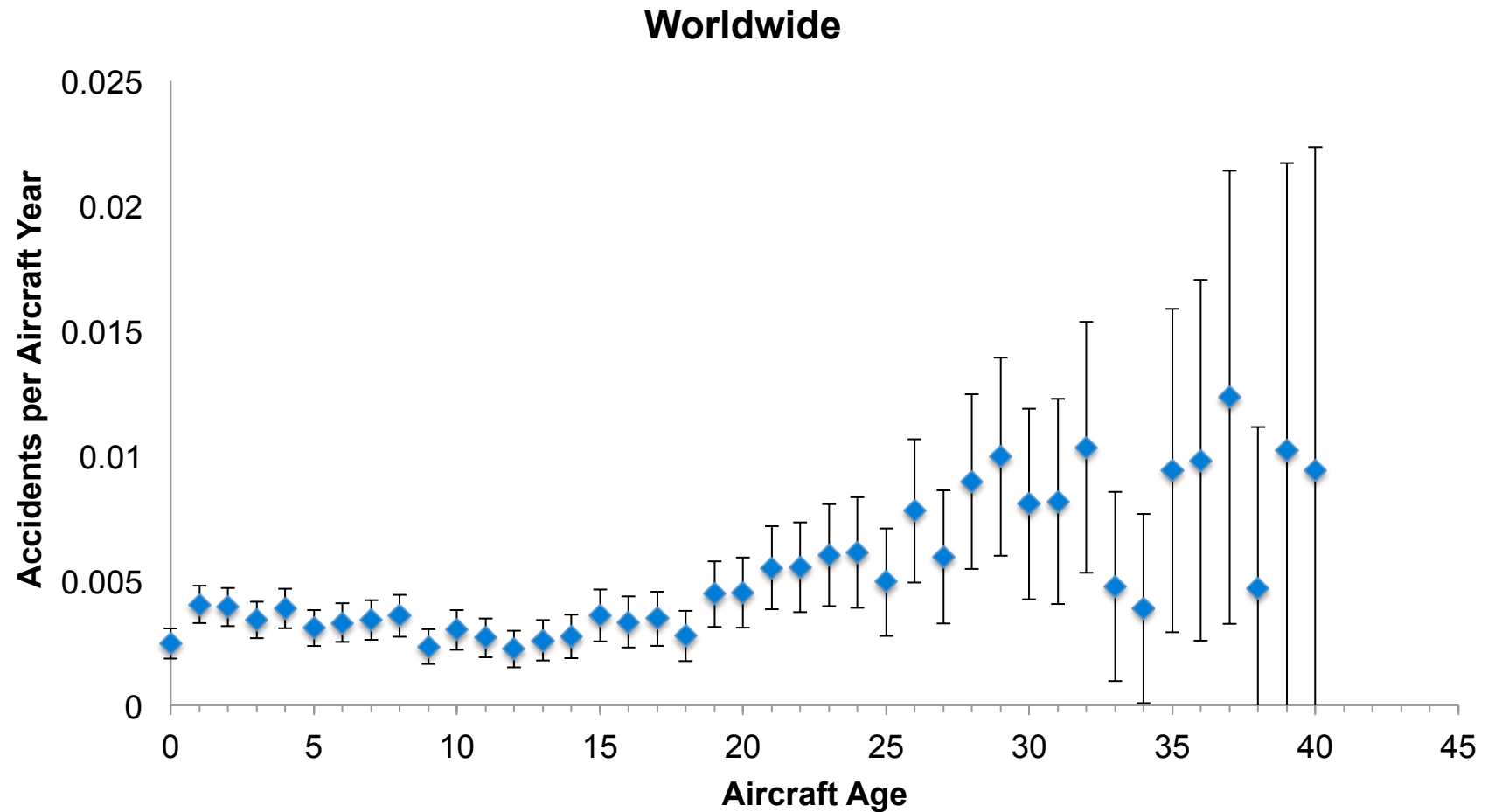
Worldwide



Error Bars Indicate 95% Confidence Interval



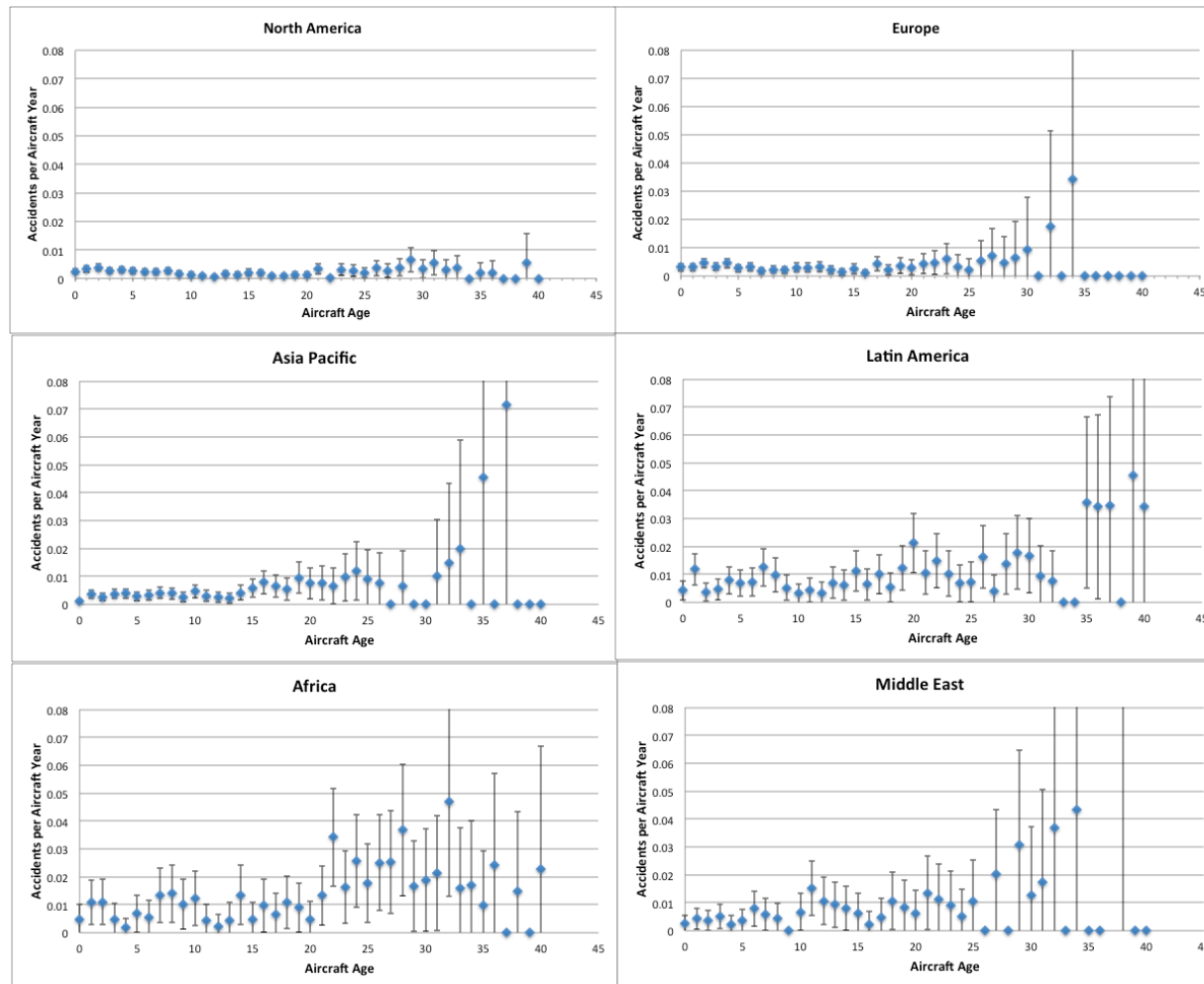
Total Accident Rate vs Aircraft Age



Error Bars Indicate 95% Confidence Interval

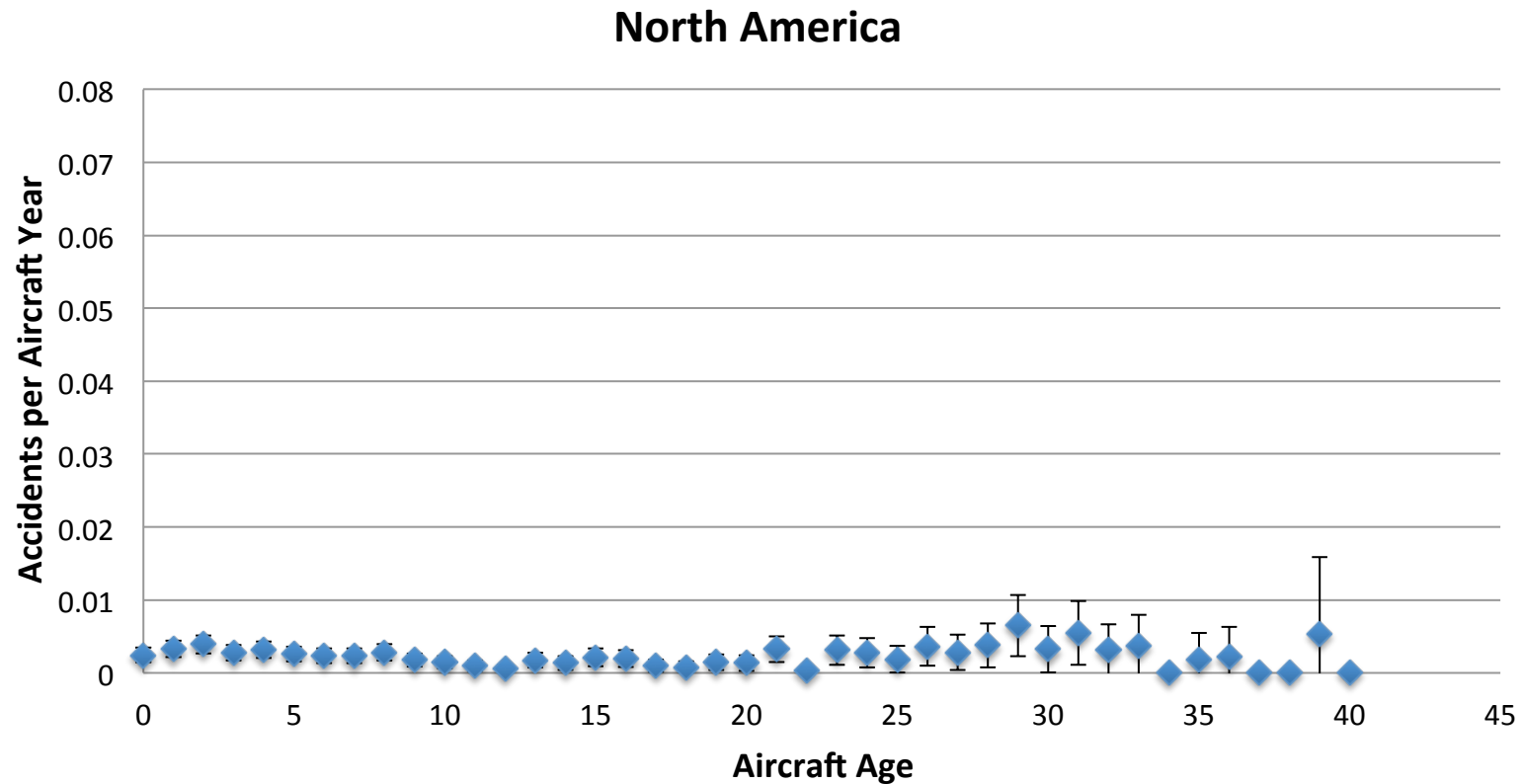


Accident Rate vs Aircraft Age by World Region



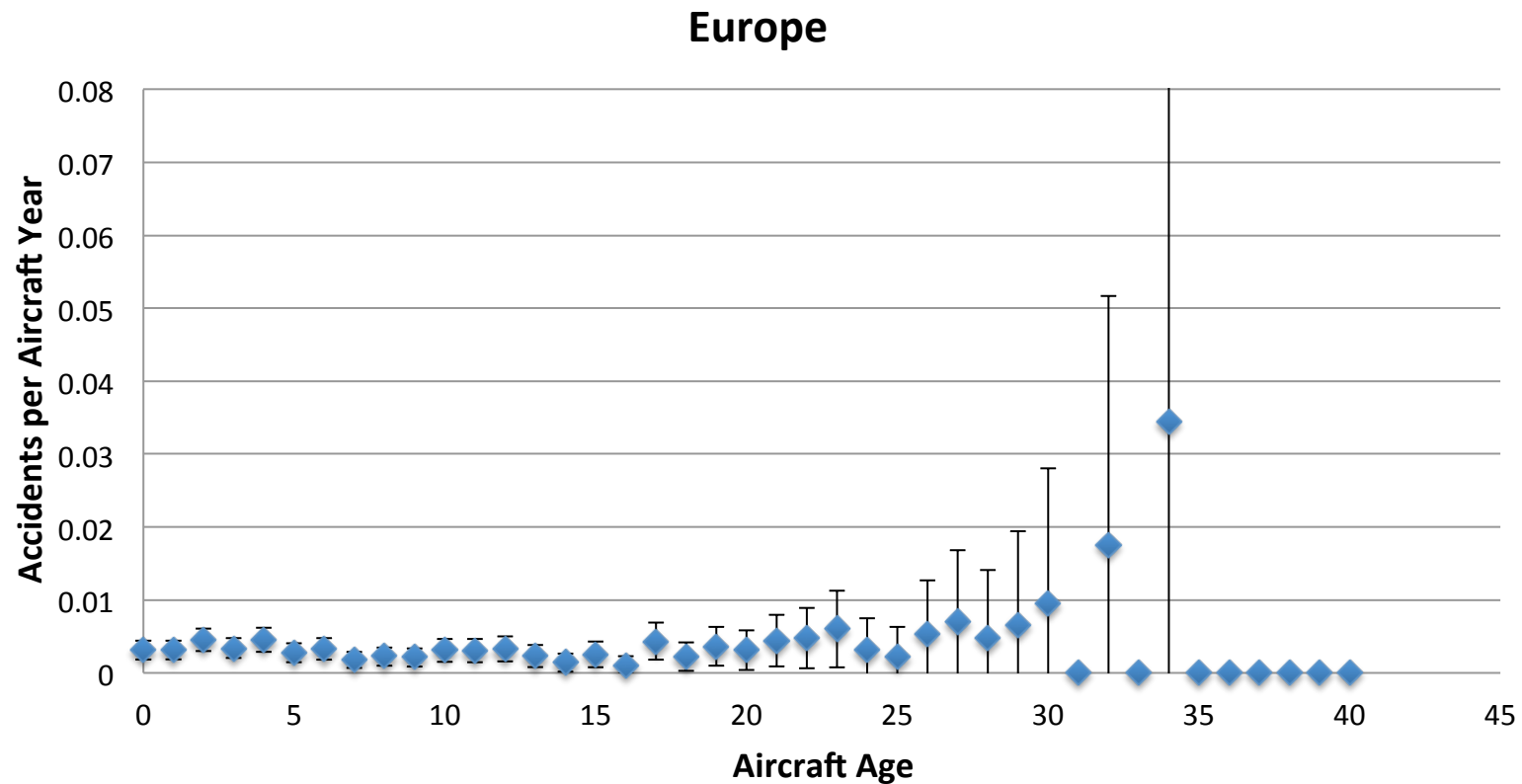


Accident Rate vs Aircraft Age North America





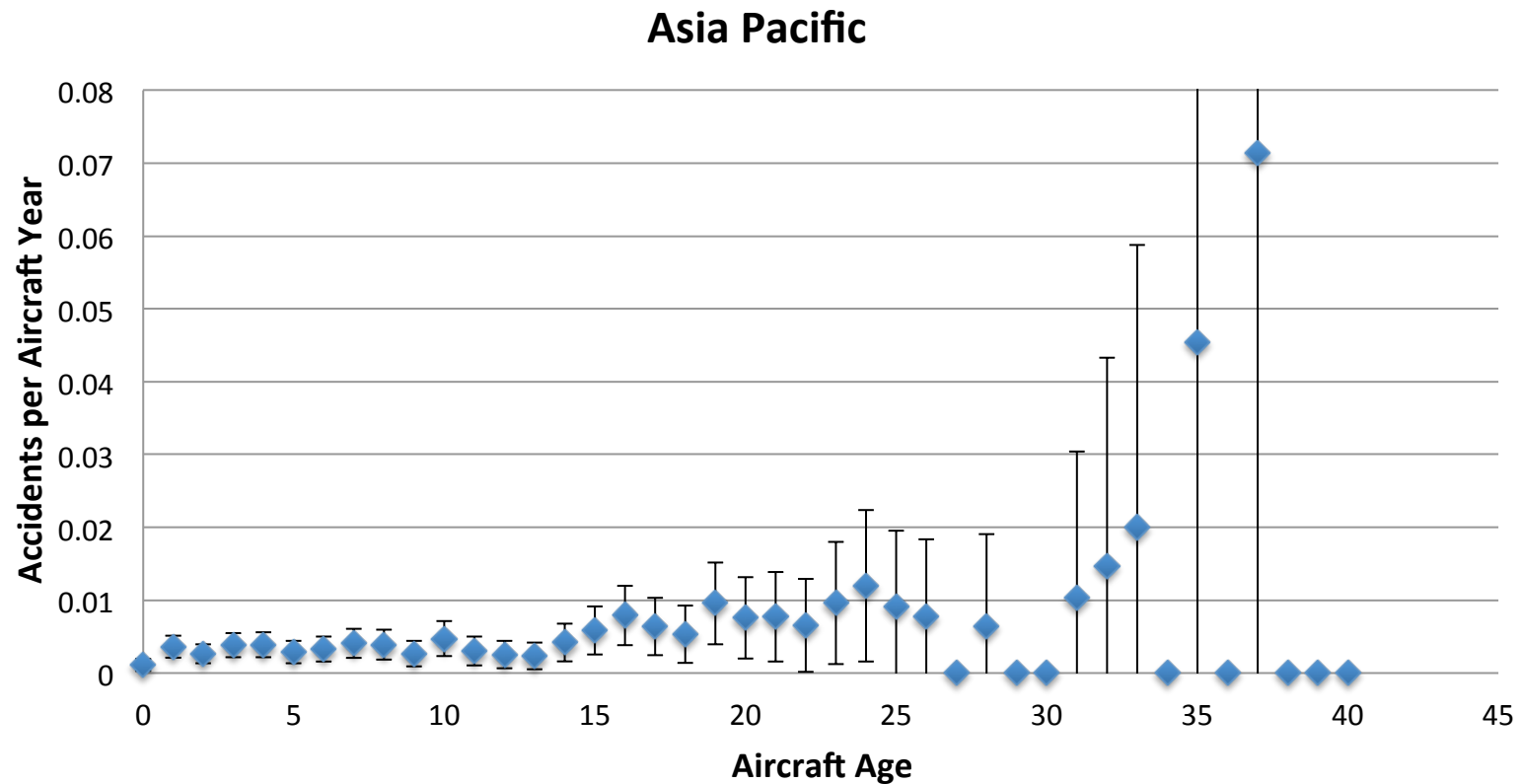
Accident Rate vs Aircraft Age Europe





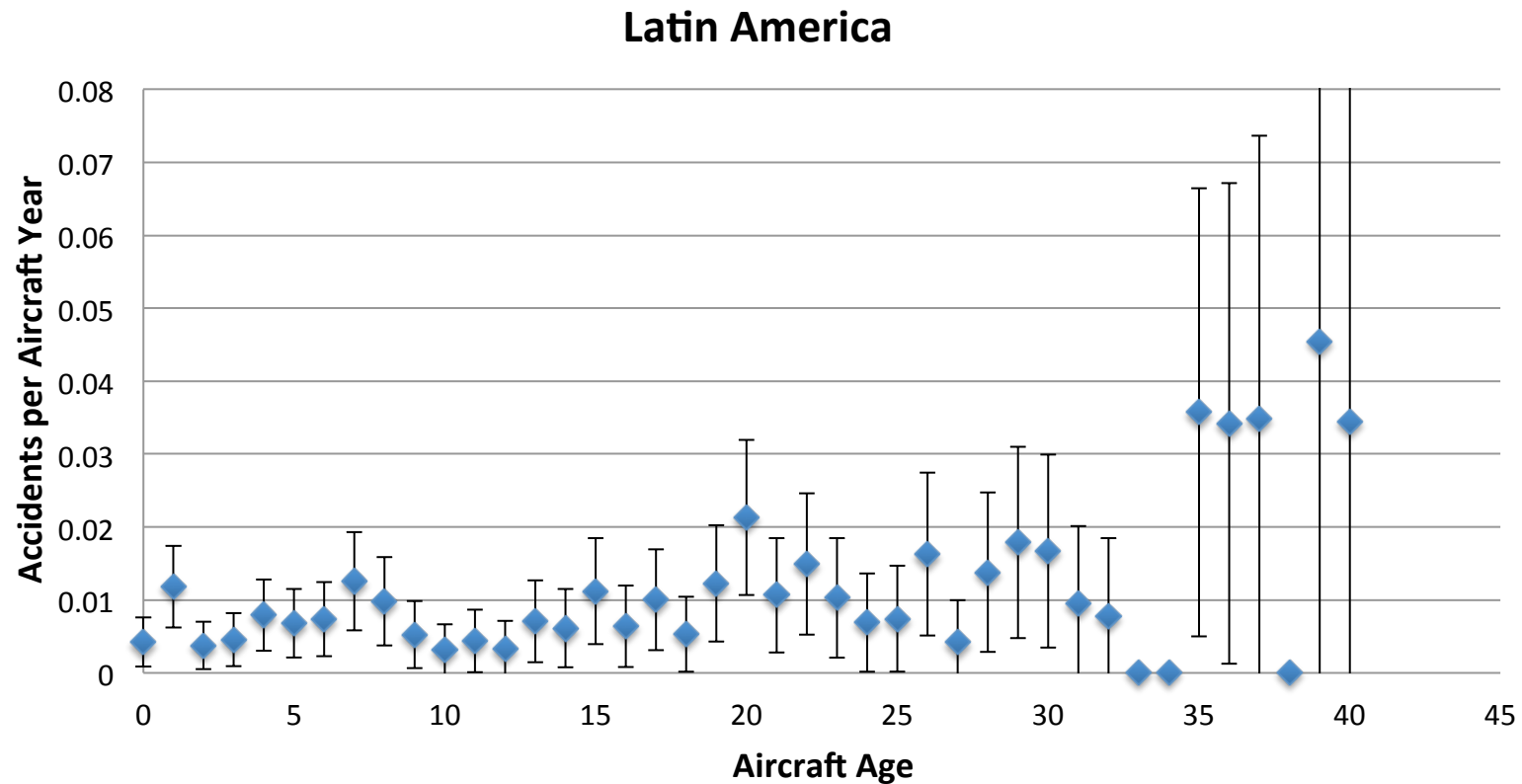
Accident Rate vs Aircraft Age

Asia Pacific



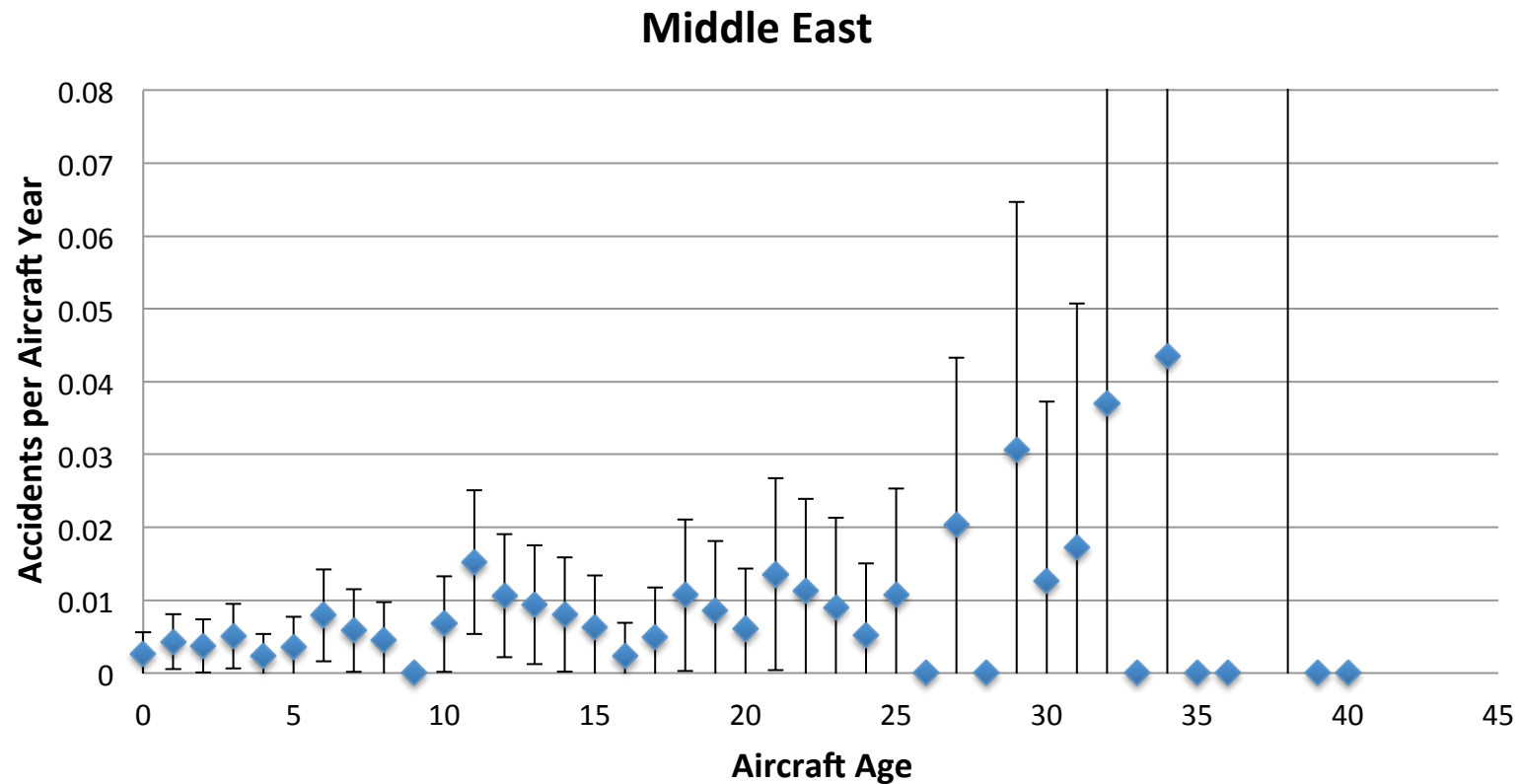


Accident Rate vs Aircraft Age Latin America



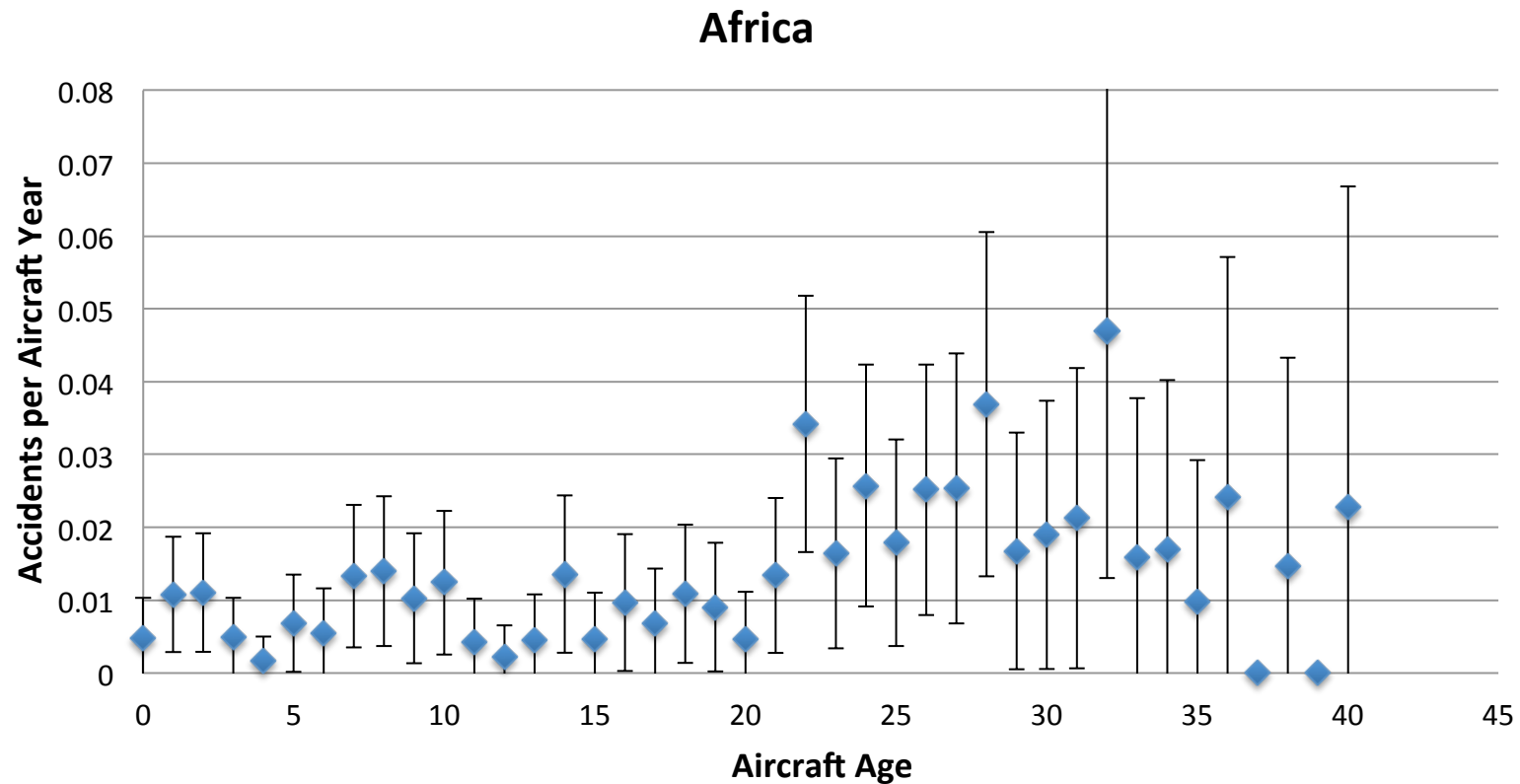


Accident Rate vs Aircraft Age Middle East



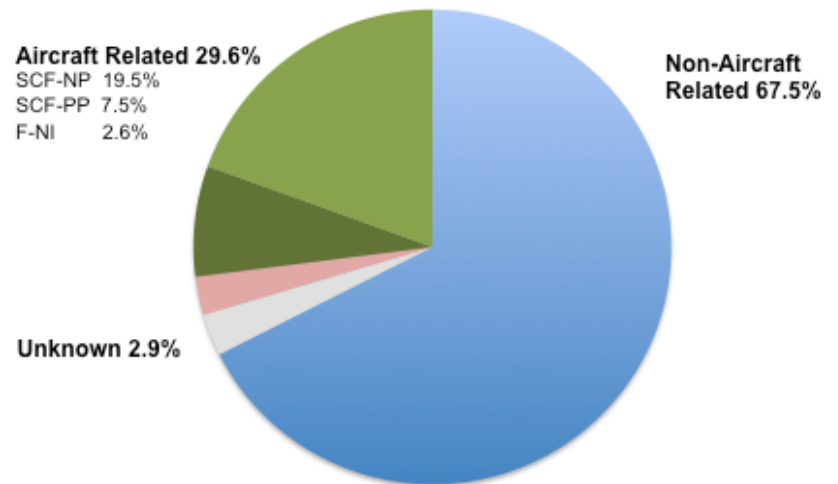
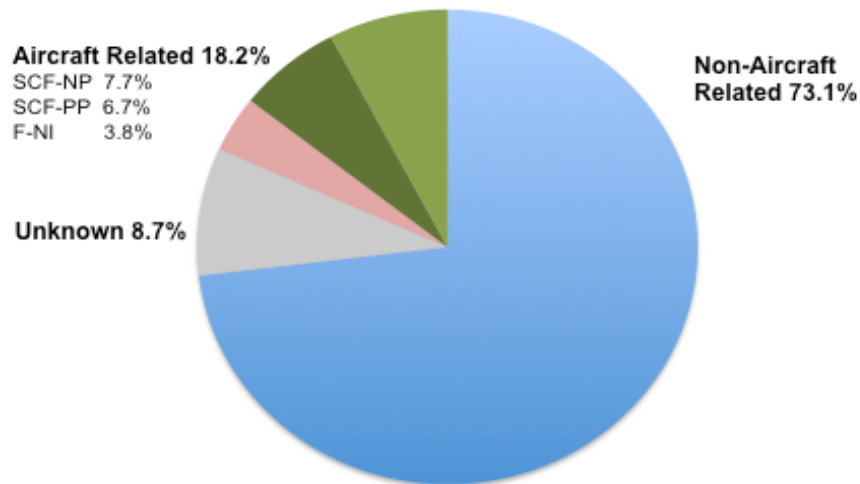


Accident Rate vs Aircraft Age Africa





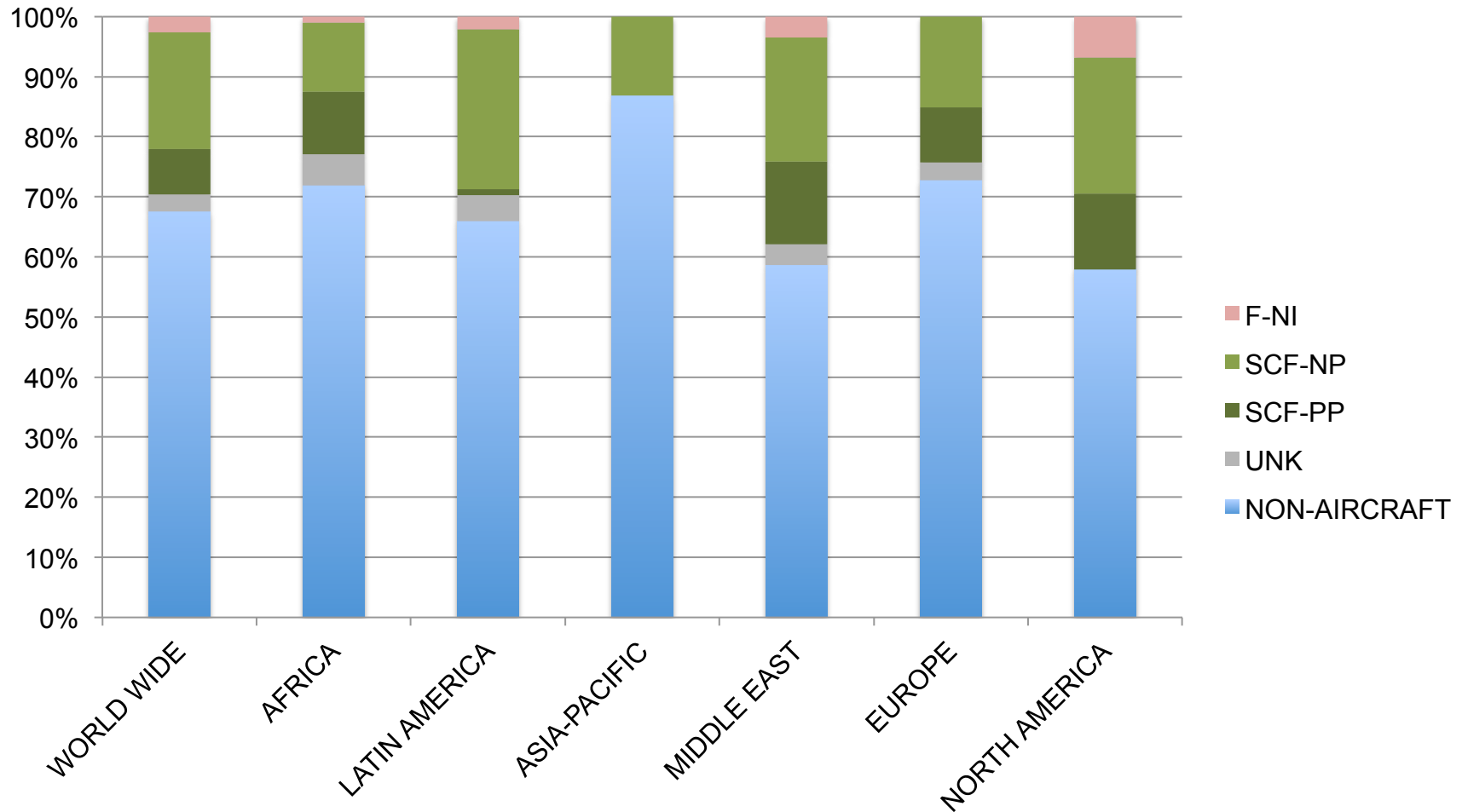
Occurrence Categories for Accidents of 20+ Year Old Aircraft





Accidents of 20+ Year Old Aircraft

Distribution of Occurrence Categories by World Region





Conclusions

- **Fatal Accident Rate**
 - No Correlation with Age up to 27 Years
 - **Total Accident Rate and Age Up to 18 Years**
 - No Correlation with Age up to 18 Years
 - Weak Trend of Increasing Rate with Age for AC > 20years
 - Increase Mainly Observed in Africa
 - No Correlation in North America or Europe
 - **Accidents of 20 +Year Old Aircraft**
 - Most Accidents are Not Related to Aircraft Factors
 - All Accidents 67.5%, Fatal Accidents 73.1 %
 - Higher Non-Aircraft Percentages in Africa vs North America
 - **Historical Analysis Does Not Support Age-Based Import Restrictions**
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