

Dimensionality Assessment of Fatigue in Collegiate Aviation Operations: A Structural Equation Modeling Approach

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Adjekum, Daniel Kwasi; Keller, Julius; and Mendonca, Flavio Antonio, "Dimensionality Assessment of Fatigue in Collegiate Aviation Operations: A Structural Equation Modeling Approach" (2023). *National Training Aircraft Symposium (NTAS)*. 29.
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Utilizing Structural Equation Modeling to Discover Relationships Between the Causes of Fatigue

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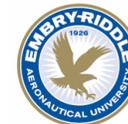
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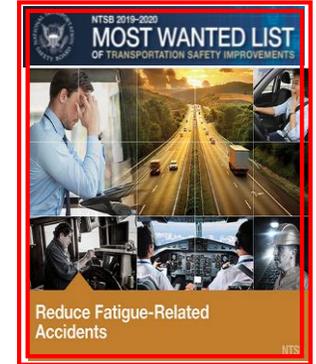
✈ Flavio A. C. Mendonca, Ph.D., MBA - Assistant Professor



Utilizing Structural Equation Modeling to Discover Relationships Between the Causes of Fatigue

Introduction

- ✈️ Fatigue has been identified as a safety hazard during aviation operations
 - ✈️ Causes of fatigue include low quality sleep, physical and/or mental exertion, and excessive workload
 - ✈️ Fatigue mitigation strategies include good quality sleep, workload management, and a healthy lifestyle
 - ✈️ Compliance with regulations is important BUT not the most effective way to combat fatigue
- ✈️ Most research studies investigating fatigue in aviation have generally targeted commercial and military operations
 - ✈️ Little to nothing has been done involving the GA community



[Colgan Air 3407](#) (2009)

Loss of Control on Approach
Colgan Air, Inc.
Operating as Continental Connection Flight 3407
Bombardier DHC-8-400, N200WQ
Clarence Center, New York
February 12, 2009



[UPS 1354](#) (2013)

Purpose of the Study

-  Understand fatigue as a multi-factorial dimension
-  Assess potential relationships among these factors using hypothesized measurement models

Research Questions

-  **RQ 1.** What is the effectiveness of proposed measurement models of factors underlying the dimension of fatigue in collegiate aviation?
-  **RQ 2.** What is the strength of relationships between the three underlying factors and the overarching dimension of Fatigue?
-  **RQ 3.** What are the variations in mean scores of demographic group perceptions of factors that underlie fatigue in collegiate aviation?

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Methods

Research Instrument

-  Collegiate Fatigue Inventory II (CAFI-II)



-  Fatigue awareness
-  Causes of fatigue
-  Lifestyle
-  Demographics

-  See [Keller et al. \(2021\)](#) and [Keller et al. \(2022\)](#) for further information about the development and validation processes of the CAFI-II survey questionnaire.

-  **Participants**  Collegiate aviation pilots from eight CFR Part 141 universities

Data Analysis

-  Data were exported into the IBM AMOS 25® and SPSS 26
-  Robust statistical procedures were utilized during this study

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Results

Demographics

Institution	(n)	Percent
Institution 1	99	23.5%
Institution 2	67	15.9%
Institution 3	56	13.3%
Institution 4	51	12.1%
Institution 5	41	9.7%
Institution 6	36	8.5%
Institution 7	31	7.3%
Institution 8	20	4.7%
Did not to answer	21	5.0%
Total	422	100%

Enrolment Level	(n)	Percent
Freshmen	74	17.5%
Sophomores	93	22.0%
Juniors	107	25.4%
Seniors	110	26.1%
Graduate	38	9.0%
Total	422	100%

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Results

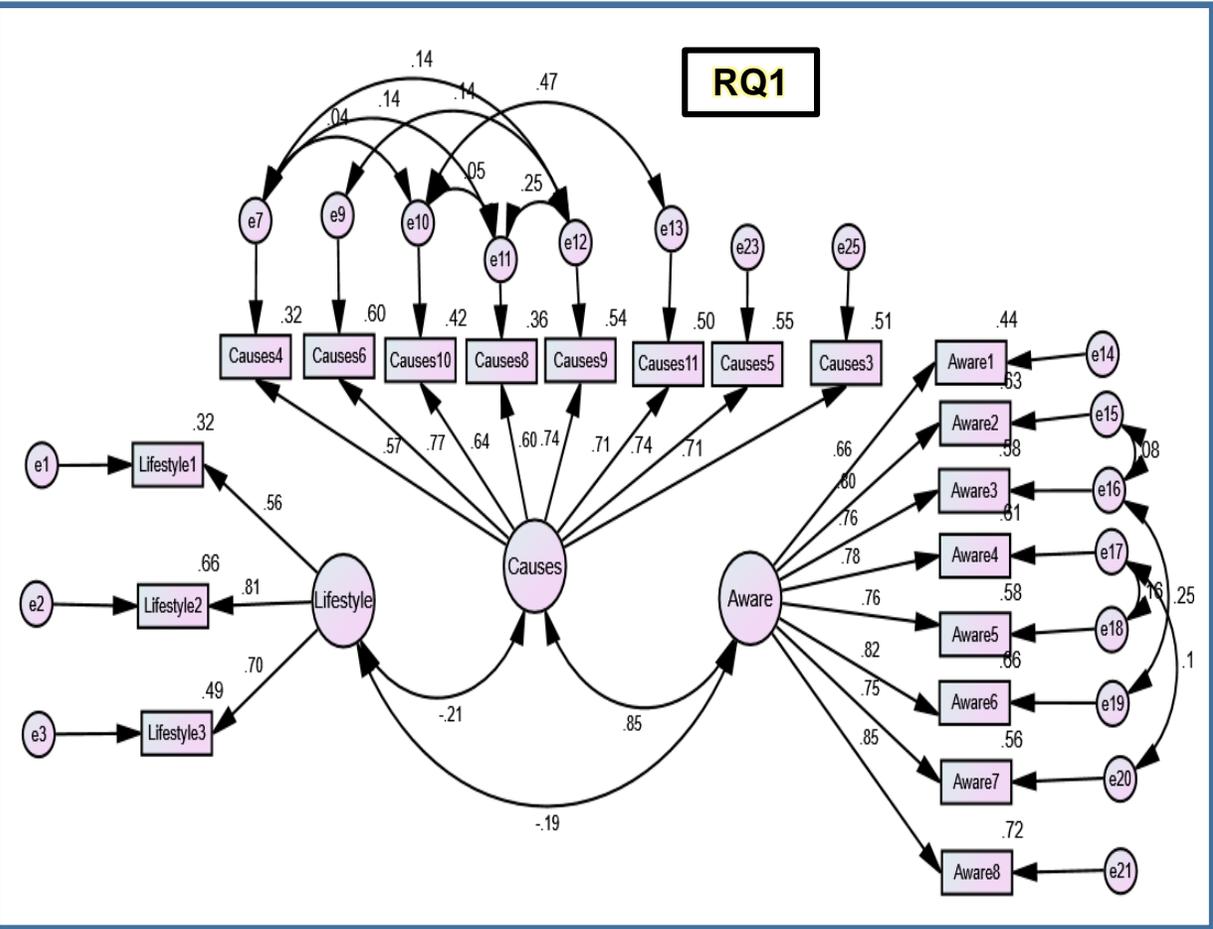
Demographics

Highest Certificate Held	(<i>n</i>)	Percent
Student Pilot	106	25.1%
Private Pilot	163	38.6%
Commercial Pilot	57	13.5%
Certified Flight Instructor (CFI/II/ME)/ATP	96	22.5%
Total	422	100%

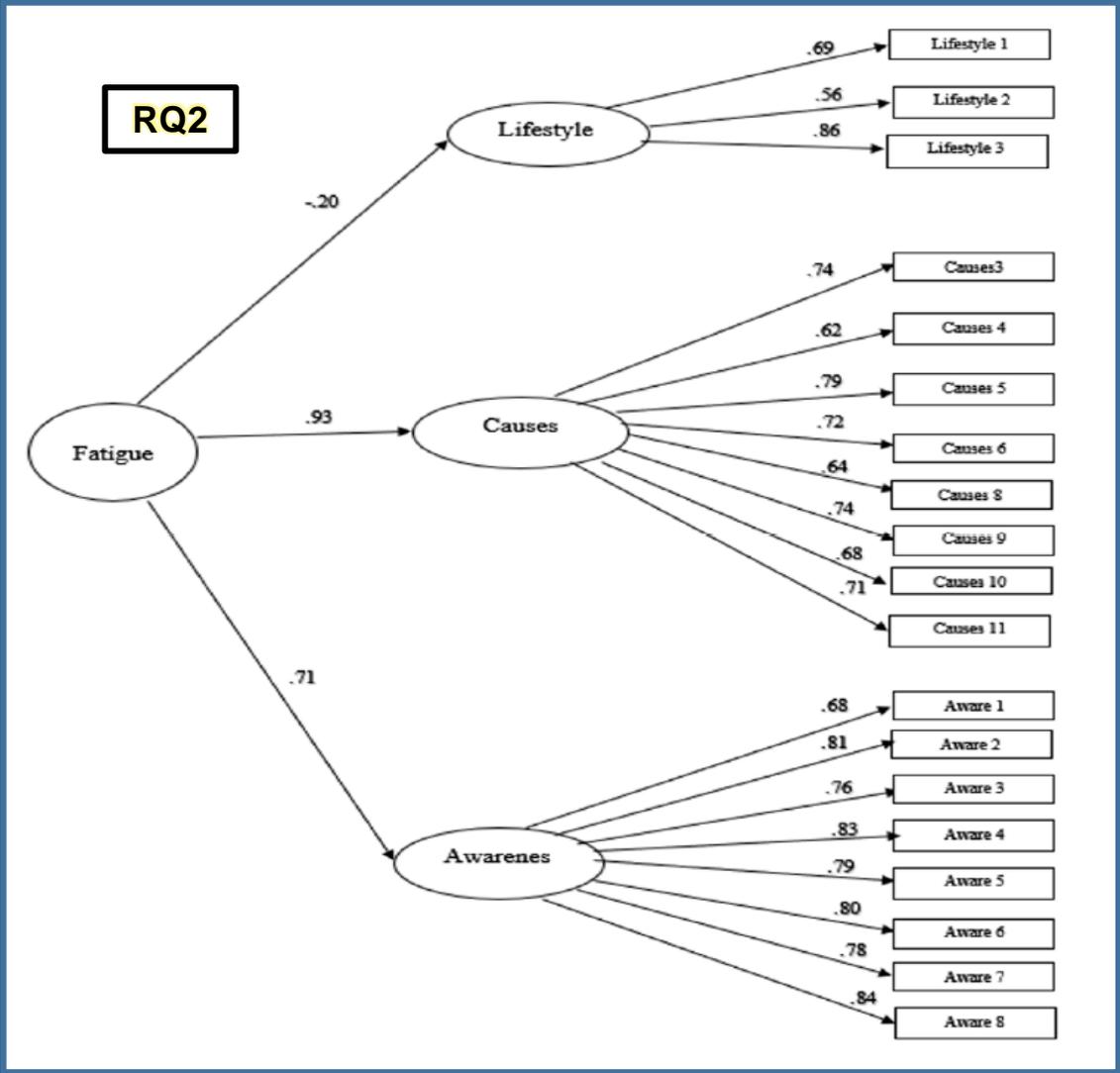
Approximate Total Flight Time	(<i>n</i>)	Percent
0–150	207	49.1%
151–300	132	31.3%
301–450	32	7.6%
451–600	9	9.1%
600+	27	6.4%
Did not answer	15	3.6%
Total	422	100%

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Results



A three-factor structural model for collegiate aviation fatigue



Full Conceptual Model of Fatigue Highlighting Strength of Relationships

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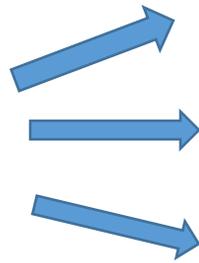
Results

RQ3

-  Academic enrollment status  there were significant differences in the perceptions of the causes of fatigue as well as in the awareness of fatigue among academic enrolment status (freshmen, sophomores, juniors, and seniors)
-  Flight certificates  there were significant differences between the mean responses of participants with different flight certificates (i.e. CFI x Commercial Pilot Certificate) for all the three variables
-  Gender  no significant difference in the models

Discussions and Conclusions

 Three explanation constructs



 Causes of fatigue

 Fatigue awareness

 Lifestyle choice

 CAFI-II  Evidence of construct validity assessed

 Direct and strong predictive relationship between fatigue in collegiate flight training and the perceptions of respondents of conditions that cause fatigue and fatigue awareness

✈ Discussions and Conclusions

✈ Academic enrollment status

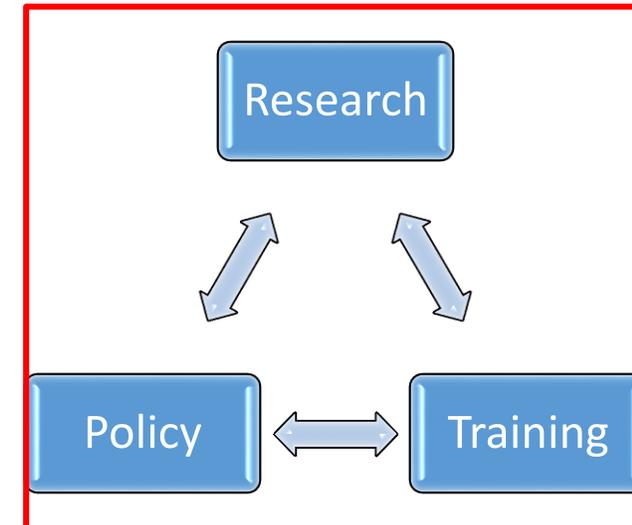
✈ Significant differences between freshman and upper level students

✈ Emphasis on fatigue risk management training embedded in basic and advanced level academic courses

✈ Flight certificates

✈ Student pilots ➡ group of certificate holders with minimal awareness of the effects of fatigue and how to manage it as compared to CFIs

✈ CFIs ➡ a relatively lower mean score on items that indicated fatigue-reducing lifestyle choices when compared to commercial pilot holders



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Limitations

-  Narrow band of age
-  Flight hours
-  Only 23% were CFIs

Future Studies

-  International universities
-  Investigate sleep quality and other fatigue contributing factors





Article

Understanding Factors Underlying Fatigue among Collegiate Aviation Pilots in the United States

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Abstract: An increase in evidence-based studies into the deleterious effects of fatigue on flight operations has been reported by key aviation groups globally. The collegiate aviation flight training environment has not been researched at the same level when compared to military and airline operations. College aged students are unique in the sense that they are tasked with classwork, studying, participation in student organizations, social activities, and often have part time jobs within and outside of the academic environment. These conditions may cause errors, incidents, accidents, poor academic performance, and undesirable health metrics. The purpose of this study was to understand fatigue as a multi-factorial dimension and to assess potential relationships among these factors using hypothesized measurement models. The research team distributed the Collegiate Aviation Fatigue Inventory II (CAFI-II) to eight small, medium, and large collegiate aviation programs in the United States. The CAFI-II primarily focuses on fatigue awareness, causes and symptoms of fatigue, and lifestyle choices. Four hundred and twenty-two ($n = 422$) valid responses were obtained. Results suggested a direct predictive relationship between fatigue in collegiate flight training and the perceptions of respondents of conditions that are known to cause fatigue. Findings also suggested that respondents who had a favorable perception of fatigue risk and management programs had a better understanding of the causes of fatigue.

Keywords: collegiate aviation; human factors; fatigue

 check for updates

Citation: Keller, J.; Mendonca, F.A.C.; Adjekum, D.K. Understanding Factors Underlying Fatigue among Collegiate Aviation Pilots in the United States. *Safety* **2022**, *8*, 46. <https://doi.org/10.3390/safety8020046>

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Thank you!

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