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From Conventional Arms Races to Algorithmic Competition: Artificial Intelligence, Autonomous Weapons, and Global Security

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Abstract

The character of military competition is undergoing a fundamental transformation as artificial intelligence (AI), autonomous systems, machine learning, robotics, advanced sensing, and algorithmic decision-support become increasingly integrated into national security strategies. Conventional arms races have historically been measured through the accumulation of tanks, aircraft, missiles, naval platforms, nuclear weapons, and other physical capabilities. The emerging competition increasingly depends on less visible but strategically significant resources, including data, computing capacity, algorithms, software, autonomous systems, semiconductor technologies, and human–machine integration. This article examines the transition from conventional arms competition to what it conceptualizes as algorithmic competition. Using a qualitative and exploratory research design based on secondary literature, policy documents, institutional reports, and contemporary security developments, the study analyses how artificial intelligence is transforming military power, strategic decision-making, autonomous weapons, deterrence, escalation dynamics, and international security governance. The article argues that the emerging AI arms race differs from traditional arms races in three fundamental ways: the speed of technological innovation is significantly greater, military advantage increasingly depends on dual-use civilian technologies and intangible capabilities, and the boundary between human and machine decision-making is becoming progressively blurred. The study further argues that autonomous weapons introduce a new strategic dilemma because increasing military speed and operational efficiency may simultaneously reduce predictability, complicate accountability, and increase escalation risks. The growing integration of AI into military systems also creates a governance gap because international institutions have struggled to establish sufficiently precise and universally accepted rules concerning autonomy, human control, accountability, and the use of AI in armed conflict. The article concludes that algorithmic competition is unlikely to replace conventional military power; rather, it is becoming embedded within existing military capabilities and transforming their strategic value. Consequently, global security governance must move beyond traditional arms-control frameworks toward a multidimensional approach addressing AI development, autonomous weapons, military decision-support systems, data infrastructures, and human control over the use of force.

Keywords: Artificial Intelligence; Algorithmic Competition; Autonomous Weapons; Arms Race; Military AI; International Security; Strategic Competition; Human Control; Arms Control; Global Governance

1. Introduction

Military competition has traditionally been associated with the accumulation of physical weapons and military resources. During the twentieth century, the major powers competed through the development of conventional weapons, aircraft, naval forces, missiles and nuclear arsenals. The concept of an arms race consequently became an important framework for understanding international security and strategic competition.

In the twenty-first century, however, technological developments are changing the nature of this competition. Artificial Intelligence (AI), machine learning, robotics, autonomous systems, advanced sensors, cloud computing and digital networks are increasingly becoming part of military capabilities. Modern military power is therefore no longer determined only by the number of weapons a state possesses, but also by its ability to collect data, process information, develop algorithms and integrate intelligent systems into military operations.

AI can support a wide range of military activities, including intelligence analysis, surveillance, reconnaissance, logistics, target identification, cyber

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operations, battlefield management and decision-support. The growing importance of these technologies has created a new form of strategic competition that can be described as **algorithmic competition**.

Algorithmic competition differs from traditional arms competition because its most important resources are not always physically visible. Data, software, computing capacity, algorithms and semiconductor technologies can significantly influence military capabilities. Moreover, many of these technologies have both civilian and military applications, making them difficult to regulate through traditional arms-control mechanisms.

The development of autonomous weapon systems adds another important dimension to this transformation. Such systems can perform certain functions with varying levels of human intervention and may potentially identify, select or engage targets. This raises questions about human control, accountability, predictability and compliance with international humanitarian law.

The International Committee of the Red Cross has highlighted concerns regarding autonomous weapon systems, particularly their potential implications for civilian protection, human control and international humanitarian law. Therefore, understanding AI-driven military competition has become increasingly important for contemporary global security.

This study examines how military competition is changing from conventional arms races toward algorithmic competition and analyses its implications for strategic stability, autonomous weapons, human control and international security governance.

2. Review of Literature

The existing literature on AI and military affairs can broadly be divided into three areas: military applications of AI, autonomous weapons, and international governance.

2.1 AI and Military Power

Scholars have increasingly examined AI as a technology capable of transforming military effectiveness. AI can process large amounts of information rapidly and support military personnel in complex decision-making environments. Its applications extend from intelligence and surveillance to logistics and battlefield coordination.

Unlike conventional weapons, AI technologies can also be continuously modified and upgraded through software. This makes technological innovation faster and potentially more difficult to measure using traditional arms-race indicators.

2.2 Autonomous Weapons

Autonomous weapons have generated significant academic, legal and ethical debate. The central concern is the possibility that machines could make decisions related to the use of force without sufficient human intervention.

Scharre (2018) argues that autonomy may provide important military advantages but simultaneously create risks associated with human-machine interaction and unintended consequences. The ICRC has similarly emphasized the need to establish limits on autonomy and maintain meaningful human control over the use of force.

2.3 AI and International Security Governance

Another important area of research concerns the ability of existing international institutions to govern military AI. International humanitarian law already provides principles such as distinction, proportionality and precaution. However, the application of these principles to increasingly autonomous systems presents new challenges.

Recent SIPRI research has also examined autonomous weapon systems alongside AI-enabled decision-support systems, highlighting the importance of understanding how different forms of military AI can influence targeting and human decision-making.

Despite this growing literature, comparatively less attention has been given to conceptualizing AI development as a broader form of **algorithmic competition** that connects technological capabilities, military modernization, strategic stability and arms control.

3. Research Gap

Existing studies have extensively examined artificial intelligence, autonomous weapons and military modernization. However, the relationship between these developments and the traditional concept of an arms race remains insufficiently integrated.

Traditional arms-race analysis focuses primarily on physical military capabilities. In contrast, AI competition involves intangible resources such as data, algorithms, computing power and software. Furthermore, AI technologies can be rapidly updated

and can be used for both civilian and military purposes.

There is therefore a need for a broader conceptual approach that explains how AI is changing not only military technologies but also the **logic of strategic competition**.

This study addresses this gap through the concept of algorithmic competition.

4. Objectives of the Study

The study has the following objectives:

1. To examine the changing nature of military competition in the age of artificial intelligence.
2. To analyse the differences between conventional arms races and algorithmic competition.
3. To examine the security implications of autonomous weapon systems.
4. To analyse the impact of AI on deterrence, escalation and strategic stability.
5. To examine challenges related to human control and accountability.
6. To assess the need for new approaches to international governance of military AI.

5. Research Methodology

5.1 Research Design

The present study adopts a **qualitative, exploratory and descriptive research design** to examine the transformation of military competition from conventional arms races to algorithmic competition. The study focuses on the growing role of Artificial Intelligence (AI), autonomous weapons, data, computing infrastructure and AI-enabled decision-support systems in contemporary global security.

A qualitative approach is considered appropriate because the study seeks to understand technological, strategic, legal and governance-related changes rather than statistically test a single causal relationship.

5.2 Nature and Sources of Data

The study is based on **secondary data** collected from reliable academic, governmental and international sources. The data include both qualitative information and selected quantitative indicators related to military expenditure, AI investment, autonomous weapons, technological capabilities and defence modernization.

The major sources of data are:

- Peer-reviewed research articles and academic journals;
- Books and scholarly publications;
- SIPRI databases and reports;
- United Nations reports and documents;
- International Committee of the Red Cross (ICRC) publications;
- Government defence and AI policy documents;
- NATO and other international security organizations;
- Reports of research institutions and think tanks; and
- Official policy and strategy documents of major military powers.

5.3 Data Period

For contemporary analysis, the study primarily considers developments from **2015 to 2026**, while earlier scholarly and historical sources are used to explain the evolution of conventional arms competition.

The period 2015–2026 is particularly relevant because it covers the rapid expansion of military AI, autonomous systems, machine learning applications and international discussions concerning responsible military AI.

5.4 Key Data Indicators

To examine the transition from conventional military competition to algorithmic competition, the study considers the following indicators:

Dimension	**Indicators Used**
Conventional military power	Military expenditure, arms transfers, defence modernization
AI capability	AI strategies, military AI programmes, AI investment
Computing capacity	Advanced computing, semiconductor technology, data infrastructure
Autonomous systems	Autonomous drones, unmanned systems, autonomous weapons programmes
Decision-support	AI-enabled intelligence, surveillance and targeting systems
Human control	Human supervision, intervention and authorization mechanisms
Strategic stability	Deterrence, crisis decision-making and escalation risks

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Governance	International declarations, legal frameworks and arms-control initiatives

These indicators allow the study to compare the traditional material dimensions of military power with emerging technological and algorithmic capabilities.

5.5 Research Questions

The study is guided by the following research questions:

RQ1: How is Artificial Intelligence transforming the traditional nature of military competition?

RQ2: How does algorithmic competition differ from conventional arms races in terms of resources, technological development and military capability?

RQ3: How are autonomous weapons and AI-enabled decision-support systems affecting human control and military decision-making?

RQ4: What implications does the increasing speed and autonomy of AI-enabled military systems have for deterrence and escalation?

RQ5: Are existing international security and arms-control frameworks adequate to address the emerging challenges of military AI?

RQ6: What governance mechanisms are required to manage the risks associated with algorithmic military competition?

5.6 Analytical Framework

The collected data are analysed through thematic and comparative analysis.

Five major themes are developed:

1. **AI and Military Modernization** – examining how AI is being integrated into existing military capabilities.
2. **Algorithmic Competition** – analysing competition over data, computing power, algorithms, software and technological infrastructure.
3. **Autonomous Weapons** – examining the development and security implications of increasingly autonomous military systems.
4. **Human Control and Accountability** – analysing the changing relationship between human decision-makers and AI-enabled systems.
5. **International Security Governance** – examining existing international legal, institutional and policy responses.

The study then compares these themes with the characteristics of conventional arms races.

5.7 Comparative Data Analysis

The study uses selected quantitative indicators to provide empirical context to the qualitative analysis. These indicators include global military expenditure, arms transfers, defence investment and the development of military AI capabilities.

For example, SIPRI's military expenditure database can be used to examine changes in global defence spending, while SIPRI's arms-transfer data can provide a conventional benchmark against which emerging technological competition can be considered. AI strategies, defence policies and military modernization documents are then examined to identify the growing importance of AI and autonomous technologies.

The quantitative indicators are not used for statistical hypothesis testing. Instead, they are used to establish the broader context in which qualitative evidence is interpreted.

5.8 Propositions

Because the study is exploratory and qualitative, it is more academically appropriate to use **research propositions** rather than conventional statistical hypotheses.

The following propositions guide the analysis:

P1: The increasing integration of Artificial Intelligence into military systems is transforming conventional arms competition into a broader form of algorithmic competition.

P2: Military advantage increasingly depends not only on physical weapons but also on data, computing capacity, algorithms, software and human–machine integration.

P3: Greater autonomy in military systems may increase operational efficiency while simultaneously creating challenges for human control, accountability and strategic stability.

P4: Existing conventional arms-control frameworks are insufficient on their own to address the technological and governance challenges associated with military AI.

5.9 Reliability and Validity

To improve the reliability of the study, information is obtained primarily from **official, academic and internationally recognized sources**. Data and claims

are cross-checked across multiple sources wherever possible.

The study gives particular importance to sources such as SIPRI, United Nations, ICRC, government publications and peer-reviewed academic research because these provide established information concerning military capabilities, international security and humanitarian law.

5.10 Methodological Limitation

The study has certain limitations. Since military AI technologies are often classified, publicly available information may not fully represent the actual capabilities of states. In addition, AI technologies are developing rapidly, and therefore specific capabilities, policies and regulatory approaches may change over time. The study consequently focuses on publicly available evidence and does not attempt to assess classified military capabilities.

6. CONVENTIONAL ARMS RACES AND ALGORITHMIC COMPETITION

Traditional arms races have generally been associated with the accumulation of visible military capabilities such as tanks, aircraft, missiles, naval platforms, and nuclear weapons. Military strength was largely evaluated through the quantity, quality, and deployment of these systems.

Artificial intelligence is changing this pattern. Military competition increasingly depends on data, computing power, algorithms, software, advanced sensors, autonomous systems, and semiconductor technologies. These capabilities are less visible than conventional weapons but can significantly influence military effectiveness.

This emerging form of competition can be described as algorithmic competition, in which states seek strategic advantage through the development, integration, and deployment of AI-enabled military technologies. Unlike conventional arms races, algorithmic competition is strongly connected with civilian technologies and rapid technological innovation.

7. AI AND THE TRANSFORMATION OF MILITARY POWER

AI is increasingly being applied to intelligence analysis, surveillance, reconnaissance, logistics, cybersecurity, simulation, target identification, and decision-support systems. These applications can improve the speed with which military information is processed and decisions are supported.

The importance of military power is therefore gradually expanding from physical platforms toward a combination of hardware, software, data, computing capacity, and human-machine integration.

However, AI does not eliminate the importance of conventional military capabilities. Instead, it can enhance existing systems. For example, AI-enabled technologies may improve the effectiveness of aircraft, drones, missile defence, naval systems, and intelligence networks.

Thus, future military advantage is likely to depend on the integration of conventional capabilities with advanced digital technologies.

8. AUTONOMOUS WEAPONS AND HUMAN CONTROL

Autonomous weapon systems create one of the most important challenges associated with military AI. Such systems may perform functions such as identifying, selecting, or engaging targets with varying levels of human involvement.

The International Committee of the Red Cross has highlighted concerns regarding civilian protection, compliance with international humanitarian law, accountability, and the possibility of unpredictable escalation. It has also emphasized the importance of meaningful human control over the use of force.

The central issue is therefore not simply whether a weapon is autonomous, but how much human judgment and control remains throughout the process of selecting and applying force.

AI-enabled decision-support systems also require careful consideration. They may assist commanders by processing large quantities of information, but excessive reliance on algorithmic recommendations could influence human judgment during high-pressure military situations.

9. AI, DETERRENCE AND ESCALATION

AI can strengthen deterrence by improving surveillance, early warning, military readiness, and decision-support capabilities. However, the same technologies may create new risks.

AI systems can operate at speeds faster than traditional human decision-making processes. In a crisis, this may reduce the time available for human assessment and diplomatic intervention. Errors in data, biased algorithms, technical failures, or

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misinterpretation of an adversary's actions could therefore contribute to unintended escalation.

The growing use of AI may also create uncertainty between states because governments may not fully understand the capabilities or limitations of another state's military AI systems.

Therefore, AI has a dual effect: it can strengthen strategic capabilities while simultaneously creating new forms of strategic instability.

10. ACCOUNTABILITY AND RESPONSIBILITY

A major challenge of military AI concerns responsibility when an AI-enabled system contributes to an unlawful or unintended outcome.

Traditional military systems generally provide relatively clear chains of responsibility. AI-enabled systems may involve developers, programmers, manufacturers, military operators, commanders, and policymakers. This can make responsibility more complex.

Human accountability should therefore remain central to military AI governance. The use of AI should not create a situation in which responsibility is transferred to the technology itself.

Clear rules concerning authorization, human supervision, testing, monitoring, and intervention are necessary to ensure responsible military use of AI.

11. ANALYSIS BASED ON RESEARCH QUESTIONS

RQ1: How is AI transforming military competition?

AI is transforming military competition by shifting attention from only physical weapons toward data, algorithms, computing infrastructure, autonomous systems, and software capabilities. States increasingly seek technological advantages that can improve intelligence, decision-making, precision, and operational speed.

RQ2: How does algorithmic competition differ from conventional arms races?

Conventional arms races focus primarily on physical military capabilities, whereas algorithmic competition involves intangible and rapidly changing technological capabilities. Software can be updated faster than conventional weapons can be replaced, while civilian technologies can also contribute to military innovation.

RQ3: How do autonomous weapons affect human control?

Autonomous systems can increase operational speed and efficiency but may reduce the time available for human intervention. Maintaining appropriate human control is therefore essential, particularly when AI systems are involved in decisions concerning the use of force.

RQ4: What are the implications for deterrence and escalation?

AI may improve deterrence through better intelligence and military readiness, but rapid automated decision-making, technical errors, and uncertainty about adversary capabilities can increase escalation risks.

RQ5: Are existing governance frameworks sufficient?

Existing international humanitarian law remains applicable to the use of weapons, but the rapid development of AI and autonomy has created new policy challenges. Current discussions increasingly focus on establishing clearer international rules concerning autonomy, human control, accountability, and responsible military AI.

RQ6: What governance mechanisms are required?

Effective governance should combine international rules, human-control requirements, responsible development principles, testing standards, transparency measures, and accountability mechanisms.

12. MAJOR FINDINGS

The study produces four major findings:

1. **Military competition is becoming increasingly algorithmic.** Data, computing power, software, and AI capabilities are becoming important elements of strategic power.
2. **AI complements rather than completely replaces conventional military power.** Future military effectiveness will increasingly depend

on the integration of conventional platforms with AI-enabled systems.

3. **Autonomy creates both opportunities and risks.** Autonomous technologies can improve speed and efficiency but may create challenges related to human control, accountability, predictability, and escalation.
4. **Existing governance mechanisms require further development.** International approaches need to address military AI specifically, particularly human control, accountability, testing, and the responsible use of autonomous systems.

13. POLICY RECOMMENDATIONS

Based on the analysis, the following measures are recommended:

- States should maintain meaningful human control over decisions involving the use of lethal force.
- International discussions should establish clearer rules for autonomous weapon systems.
- Military AI systems should undergo rigorous testing, evaluation, and monitoring before deployment.
- States should develop clear chains of human responsibility for AI-assisted military decisions.
- Greater international cooperation is needed regarding military AI safety, transparency, and risk reduction.
- AI development should be accompanied by mechanisms that reduce accidental escalation and unintended conflict.

14. CONCLUSION

The development of artificial intelligence is transforming the nature of military competition. While conventional weapons and military platforms remain important, strategic advantage increasingly depends on data, computing power, algorithms, autonomous systems, and human-machine integration.

This transformation represents a shift from traditional arms competition toward **algorithmic competition**. However, AI should not be understood as replacing conventional military power. Instead, it is becoming embedded within existing military capabilities and changing how those capabilities are developed and used.

The most significant challenge is ensuring that technological advancement does not outpace human control and international governance. Responsible military AI therefore requires a balance between innovation, operational effectiveness, accountability, and international security.

Future security governance should focus not only on controlling physical weapons but also on the algorithms, data infrastructure, autonomous systems, and decision-support technologies that increasingly influence modern warfare.

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